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Trends in Occupational Disease Surveillance Reports in Connecticut and Assessment of Under-Reporting Using Capture-Recapture Analysis

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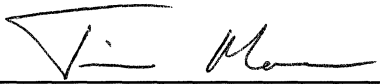
Major Adviser 

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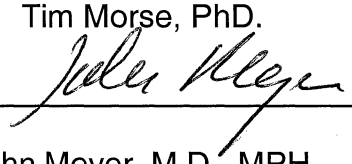
Associate Adviser 

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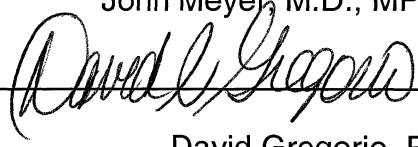
Associate Adviser 

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A. Introduction

Hippocrates, as early as the fourth century B.C, apparently saw adverse effects on miners and metallurgists caused by exposure to lead.[1] Scientists later recognized that the fumes of some metals were dangerous and suggested preventive measures in 1473 as well as attributed lung disease among miners in the Carpathian mountains to the inhalation of certain kinds of mineral dusts.[1] Low back pain is one of the oldest recognized occupational health problems in history. In 1713, Bernardino Ramazzini, the "founder" of occupational health medicine, referred to "certain violent and irregular motions and unnatural postures of the body by which the internal structure" is impaired.[1, 2] Ramazzini examined the harmful effects of unusual physical activity on the spine, such as sciatica caused by constantly turning the potter's wheel, lumbago from sitting, and hernias among porters and bearers of heavy loads.[1, 2]

In the United States, occupational health problems received little attention until the 20th century.[1, 2] The US Bureau of Labor was created in 1885 and later became the Department of Labor only in 1913. Then, the goals included no mention of workers' health beyond promoting the material, social, intellectual, and moral prosperity. Protective Legislation came along slowly and in 1908 the Federal Government provided limited compensation to civil service employees injured on the job.[1, 2]

New York became the first state to institute a workers compensation law in 1910. The first significant Federal Legislation came in 1969 with the Federal Coal Mine Health and Safety Act. The landmark Occupational Safety and Health Act (OSHA) followed this legislation in 1970.[1, 2]

Occupational injuries and illnesses constitute a very significant health problem. The National Institute for Occupational Safety and Health (NIOSH)funded study published in 1997 showed that in 1992, indirect and direct (including administrative) costs of occupational injuries were $145 billion, and of occupational illnesses, 26 billion (a total of $171 billion)[3]

The above costs compared to the costs of other diseases for the same year were as follows: $33 billion for Acquired immunodeficiency Syndrome, $57 billion for Alzheimer's disease, $164 billion for circulatory diseases and $171 billion for cancer.[3]

In California for example, the direct ($7.04 billion) plus indirect ($13.62 billion) cost were estimated to be $20.7 billion annually.[4, 6] Injuries cost $17.8 billion and illnesses $2.9 billion. These estimates were said to be low because: (1) they ignore costs associated with pain and suffering, (2) they ignore home care provided by family members, and (3) the numbers of occupational injuries and illnesses are likely to be undercounted.

A population based study in Connecticut to determine the social and economic impact of work related musculoskeletal (WRMS) showed that respondents had spent an average of $489 annually out-of-pocket. [5] Only 21 % of individuals who had medical visits or procedures reported having them paid for by workers' compensation.

While acute occupational injuries are reasonably well documented through workers' compensation reports and OSHA surveys, occupational illnesses (such as musculoskeletal conditions or MSDs, occupational asthma, and occupational cancer) are significantly under reported. [7]

The United States does not have a comprehensive national surveillance system of occupational injuries and illnesses. [1, 2, 3, 4] Lacking this system, major sources of US occupational health data include the Bureau of Labor statistics (BLS) annual survey of occupational injuries and illnesses, workers' compensation records and physician reporting systems. Occupational illness surveillance programs have been developed under the National Institute of Occupational Safety and Health under the Sentinel Event Notification System for Occupational Risks (NIOSH SENSOR) program as well as by individual states in order to better understand the magnitude and trends of occupational illness and to provide the basis for interventions [8,9,10,11,12] However, to date there has been little regionalization of information on emerging trends and intervention materials, only low to moderate community participation, inadequate focus on the intervention side of surveillance, and very limited or un-evaluated interventions. Occupational disease surveillance programs have discovered that targeted, industry-specific surveillance efforts have been effective in both improving reporting for the targeted conditions and in designing and implementing interventions, since they allow for finding interventions and customizing materials that are appropriate for the industry, informing area physicians to investigate possible occupational linkages for patients working in the industry, and more efficiency reaching the industry through contact with industry associations and trade groups and unions.[3, 7,8,9,10]

In 1990, the Connecticut Departments of Public Health and Labor published a baseline report entitled Occupational Disease in Connecticut in order to develop a coordinated and comprehensive approach for recognition and evaluation of occupational diseases. [7, 9, 13, 14, 15,

The vision underlying this integrated activity is that the use of data pertaining to occupational diseases leads to action to prevent these conditions. Thus knowledge of occurrence and causes of occupational diseases provides the basis for creating intervention and education programs to reduce those diseases in the work force. [3, 4]

B. Project Objective

This thesis project was designed to compile and analyze the last 7 years of available data (1995-2001) on occupational disease from the Workers' Compensation data source, Occupational Disease Surveillance Program, and Conn-OSHA database. This data had been compiled annually, but had never been combined as a way of evaluating long-term trends. In addition, combining the seven years of data allowed evaluation of occupational illnesses for smaller industries that do not have enough cases annually to allow statistical interference. Industry-specific data has been found to be critical for targeting interventions (such as industry-specific best practices and educational materials) as such this will form the basis for much more effective prevention of these conditions.[13]

Matching the data across the data sources allowed an expanded use of the "capture-recapture" technique for estimating the magnitude of unreported cases. [7, 16]

This technique had been successfully used for estimation of musculoskeletal conditions in Connecticut, but it had been limited by the sample size for evaluating less common conditions or extending the analysis to smaller industrial segments.[7] The technique involved matching cases from different databases, and comparing the proportion of matched to unmatched cases to estimate un-reported cases.

Data were analyzed by small industry division (3-digit Standard Industrial Classification or SIC Code) and occupation. Trends for categories of disease (MSD, lung and respiratory disease, skin conditions, noise-induced hearing loss, infectious disease, and other diseases) were analyzed.

C. Magnitude of Occupational Disease in Connecticut

Occupational diseases are a potentially under-recognized source of disability given the wide disparity in reporting requirements and procedures that exist in various jurisdictions.[3,4, 7,11, 12, 16] Nonetheless, an occupational disease could have major impacts on worker health, ability to work, and employer costs. Some diseases, such as cancers from asbestos exposure or HIV and hepatitis from exposure to blood-borne agents in health care, can be fatal.[3, 11, 17] Other diseases, such as carpal tunnel syndrome from ergonomic problems can result in high levels of disability from loss of use of the hands. Prevention efforts, such as effective health and safety committees, ergonomic programs, or use of safety devices can result in substantial reduction in diseases and costs; in theory, all occupational diseases are preventable. [3,4, 5, 6,] The effects of occupational exposures range from musculoskeletal diseases, lung diseases, cancer, hearing loss, and dermatitis to more subtle psychological effects many of which are only now beginning to be recognized.[3,13,17] Workplace exposures include repetitive movements and compressions, awkward postures, airborne contaminants, ionizing radiation, ultra-violet and visible light, electric and magnetic fields, infra red radiation, microwaves, heat, cold, noise, extremes of barometric pressure, and stress. These exposures may also interact with other chemical, physical or biological agents. For example, cardiovascular diseases may be related to a combination of physical, chemical and psychological job stresses. The workplace can also be the source of a wide range of infectious disease. Hospital workers in particular must be concerned with protection against hepatitis B, hepatitis C, tuberculosis, influenza and other viral infections including Acquired Immune Deficiency Syndrome (AIDS). The costs associated with deaths and injuries, loss of wages, medical

expenses, insurance administrative costs, fire losses and other indirect expenses are very high.[4, 5, 6]

Unfortunately, the true magnitude of health and economic impacts of occupational diseases and injury remain largely unknown. First of all, the recording of data on workers' illnesses and deaths is often incomplete or erroneous. Physicians frequently fail to relate observed diseases to occupational exposures. [17, 18, 19, 20] This is particularly true for neurological-based illnesses and for chronic degenerative diseases such as arteriosclerosis and chronic obstructive respiratory ailments. In other cases, the diagnosed causes of death may not be coded onto the death certificates.

Even when the required information is available, it may not be used to promote worker protection. Secondly, because the health effects of chronic exposures to various toxic agents in the workplace are delayed, and because many workers change jobs frequently, by the time a disease manifests itself it may be difficult to relate it to a particular exposure or combination of exposures. Thirdly, even if an association between a specific disease and given toxic agent is known, it is often difficult to quantify the concentration of the toxic agent to which the worker was exposed and to estimate the intake and the accompanying dose. [17, 18, 19, 20]

Economic considerations also tend to delay or reduce attempts to self-regulate occupational health problems. In large corporations, the directors and officers acting on behalf of the stockholders may insist on operating industrial facilities with emphasis on profits rather than occupational health. For example, they may insist that a refinery be kept in operation, with minimum down time for maintenance or overhaul, at the expense of worker health and safety.

There are also substantial problems with both externalized costs since Occupational disease is not recognized and paid for under WCC, and also there are aspects of WCC insurance that buffer costs so that employers don't realize the savings from prevention. [21, 22]

Moreover, workers themselves frequently object to controls designed to enhance health and safety when such measures slow production or interfere with comfort. This is especially true in times of economic recession, when people fear losing their jobs. In addition, there is chronic shortage of people qualified to investigate and control exposures in industry. [12, 21, 22]

Another problem is that occupational exposures and diseases are constantly changing requiring more refined methods to uncover the subtle injuries and disabilities resulting from low level exposures, on the job psychological stress, and other non-physical or chemical hazards.

Conducting more dose-response studies entails not only training more health professionals in the necessary disciplines, but also developing better record keeping and health data systems to facilitate epidemiological studies.[17, 18, 19, 20]

The OSHA Act of 1970 resulted in the establishment of the Department of Health, Education and Welfare's National Institute for Occupational Safety and Health (NIOSH).[1, 2] The act authorizes the NIOSH to conduct research and identify industrial hazards, as well as to promote occupational safety and health through education and the dissemination of information. The OSHA Act provides standards for safety in the workplace and sets standards for safety in the workplace and maintaining of compliance with these standards. OSHA also has the authority to set and enforce regulations for

workplace safety and health through civil penalties. Although there were thousands of federal contractors, inspection and enforcement activities were extremely limited because of inadequate funding and insufficient staff. This regulation however, resulted in an important shift in governmental involvement in the area of occupational health promotion. The focus of employers shifted from treatment oriented medicine to preventive measures, a strategy necessary to reduce occupational disease.

D. Progress in Connecticut

The Occupational Disease Surveillance System (ODSS), based on required physician reports of occupational diseases, is maintained by the Connecticut Department of Public Health (DPH) in cooperation with the Connecticut Department of Labor (DOL). [13] DPH also maintains the Connecticut Tumor Registry and Vital Statistics Division, which have been used for occupational disease cluster and mortality studies. [23, 24, 25]The ODSS captures variables relating to industry, occupation, workers and their disease(s). In Connecticut, physicians and clinical laboratories are required to report blood lead results, toxic levels of carbon monoxide, and mercury in blood or urine. Reporting is mandated by the DPH Commissioner through the Annual List of Reportable Diseases (CGS19a-215; Connecticut Public Health Code Sec. 19a-36-A2 through 19a-36-A2 through 19a-36-A5, inclusive). [13] Additionally, physicians are required to report all conditions that they believe may be due to occupational exposure (CGS 31-40a).[13]

The ODSS serves as a computerized database repository for all individuals who have been reported by physicians as having an occupational disease.[13] To the extent that there is under recognition and under reporting of occupational disease, the ODSS is not a comprehensive system.[7, 13] Workers' Compensation Commission (WCC) data are collected separately from DPH's ODSS data. There are limitations for workers compensation data (such as clarity of diagnosis), since it is compiled by employers rather than physicians. The Occupational Health Program (OHP) uses reports from the ODSS to conduct follow-up with cases, to identify clusters of occupational disease, and to initiate investigation and intervention activities. Although resources in DPH to conduct interventions are limited, some workplace visits are made, and recommendations are also

made to employers to encourage them to utilize Connecticut OSHA's (Conn-OSHA) Consultation Program, which offers advice to small businesses about how to correct health and safety hazards in the workplace. [7, 9, 13, 14, 15]

Data are shared with physicians via a number of publications, including the trimester newsletter, Occupational Airways, and special issues of the Connecticut Epidemiologist, which are mailed to 5,000 physicians. Additional communication is maintained with those physicians who report occupational diseases to DPH. [7, 9, 13, 14, 15]

DPH shares data with the WCC and Department of Labor (DOL) as part of the integrated system of occupational disease surveillance in Connecticut. Data from the Workers' Compensation System and the Department of Labor are reviewed annually by Tim Morse, under subcontract from the WCC, in conjunction with DPH data, and a report is published in accordance with the provisions of the Occupational Health Clinics Bill. [6, 7, 9, 13, 14, 15]

DPH also shares data and information on occupational disease and intervention initiatives with the Northeast regional states, as part of an annual surveillance conference. NIOSH (National Institute of Occupational Safety and Health) uses Connecticut Vital Records data to report on the extent of respiratory disease mortality in Connecticut, and aggregate numbers of elevated blood lead level reports are shared with NIOSH.[13] A system has not been established for sharing data about other occupational diseases with NIOSH, since a national occupational disease surveillance system does not exist. [3, 12]

E. Trends in Time over the Past 7 years/ Occupational Disease surveillance

Occupational illnesses are preventable, non-traumatic disorders that are caused by or significantly aggravated by work. Compared to acute traumatic injuries, occupational illnesses are often not diagnosed or reported to workers' compensation making tracking difficult. The Connecticut Workers' Compensation Commission publishes an annual report of occupational illnesses which is an analysis, interpretation, and feedback of data regarding the workplace and workers' health.[13, 14, 15] By observing trends in time, place and persons, changes are observed or anticipated and appropriate action, including investigative or control measures, can be taken which is the bases of surveillance. The lack of a comprehensive occupational health data collection system in the U.S. and Connecticut has led to reliance on piecemeal data sets produced by systems not designed for surveillance. [12,13]These systems involve obstacles that filter out work-related health problems at various steps. Lack of reporting can be attributed to the following: (1) physicians lack of awareness of the reporting law, (2) physician lack of awareness that aggravation of asthma, hypersensitivity and MSDs from work exposures are reportable conditions,

(3) physician fear of programs perceived as involving legal and government issues, (4) physician lack of training, familiarity expertise and difficulty in diagnosing occupational illnesses in general and (5) physician workload and demands on time for completing multiple record requirements. [12, 17, 18, 19, 20]

Carpal tunnel syndrome is one of several MSDs of the upper extremity that include tendonitis, tennis elbow (epicondylitis), trigger finger, thoracic outlet syndrome and Raynaud's disease (vibration white finger). Carpal tunnel syndrome is a disorder of

the median nerve as it crosses an anatomical tunnel in the wrist formed from bone, ligament, and tendon. Forceful and repetitive motions over time, especially when done in an awkward hand posture, damage soft tissues that swell and entrap the median nerve. The severity of the illness ranges from reversible mild symptoms of pain, cramping, numbness and tingling in the thumb and adjacent fingers to irreversible nerve damage, atrophy of the fleshy thumb muscle, and permanent disability. Connecticut data show underreporting of MSDs.

Morse et al in a population-based survey of work-related muscoloskeletal disorders (MSD) found that only 10-12% of MSD was reported to workers' compensation, and also identified risk factors for and social and economic consequences of MSD [7]

There have been extensive efforts undertaken in occupational disease surveillance by both UCHC and the participating 7 Northeast states surveillance programs. UCHC activities include hosting an annual 2-day conference of Northeast states that has been used to pilot information exchange practices. A significant finding of the importance of this activity is that participation in the conference has grown consistently over the 12-year history of the conference, with excellent qualitative evaluation of the usefulness of the conference, with activities tracked in annual minutes of the conference.

State occupational disease surveillance programs are designed to identify industry-specific occupational diseases and exposures.[13] Examples of such conditions, most of which are on the NIOSH (National Institute of Occupational Safety and Health) priority list, that have been documented in the Northeast States annual meetings include: occupational asthma from isocyanates in auto body shops, latex in health care workers,

mold exposure in schools; and from chemicals used in fingernail salons; musculoskeletal disorders in patient lifting in health care and scanning in supermarkets; carpal tunnel syndrome in packaging machine operators, electrical component assembly, and sewing machine operators; burn hazards in teen workers working in fast food establishments; lead poisoning in bridge construction and firing ranges in schools and in law enforcements; silica in road construction and in abrasive blasting in construction; formaldehyde exposures for funeral directors; pesticide use in greenhouses; and carbon monoxide exposures from propane forklifts in blueberry workers and from floor buffing equipment in offices. The ability to identify these conditions and exposures at an industry-specific level creates tremendous opportunities for target interventions that can be transferred between states.

F. Industries and occupations most at risk

The service sector had the largest occupational illness cases in the WCC database for the seven years (Figure H-2.4): There were 23% of disease reports from this sector. The manufacturing sector reported 21% of the cases. The data also showed that the government (both local and state), represent 20% and 13% of cases, respectively. The retail sector represented 9% of reported diseases and the remaining sectors reported below 9% of cases.

G. Methods

Results were analyzed using tabular analysis and descriptive epidemiology. Capture-recapture methods in epidemiology are used to estimate or adjust for the extent of underreporting using information from overlapping lists of cases from distinct sources.[16] These methods have their origin from animal ecology and have also been used in population studies by demographers. Sekar and Deming noted the number of births from a registrar's list and compared these data with the result of a complete house -to- house canvass.[26] By comparing these lists, they found the number of births recorded in both which they denoted as C, the number of entries only recorded on the registrars list: N1, and the number of births found by the canvass: N2. They then estimated the total number of births from these three quantities by assuming that, with respect to the registrar's list, the ratio of known to unknown births in the canvass was the same as the ratio of known to unknown births in the whole population. Sekar and Deming noted that there were several inherent assumptions. These include; 1.) There were no coverage errors with respect to the scope of area and /or time period in which events were recorded. 2.) The information sources were independent (i.e. the probability of an event being recorded by one source did not depend on whether it was recorded by the other source). 3.) There were no misclassification errors with respect to determining whether a particular event had been recorded by either both information source or only one of them (i.e. a perfect matching rule existed for linking the two information sources together in terms of the number of events which were recorded by both). If these assumptions held, then an estimate of the total population size was given as $N=C+N1+N2+N1N2/C$.

Capture–recapture methods are simple methods that can be introduced in the planning stage of prevalence studies to enable investigators and those who subsequently read their reports to adjust for or estimate missing cases and the total affected population.[7, 16, 26, 27] This was possible if investigators kept track of the nature of the ascertainment of cases by source, as well as if they collected and reported data that allowed calculation of the number of cases by source intersection. Hook and Regal further adapted capture-recapture methods in epidemiology to provide population parameter estimates based on two or more incomplete sources; to refine incidence estimates and their upper and lower bounds; and to estimate the completeness of apparently exhaustive surveys.[16, 27] The extent of overlap of cases from the two sample sources determined population estimates; for example, low overlap indicated a large total population; while a high degree of overlap indicated that the two sources comprised of a large proportion of the total population, and the number of additional un-identified cases were few. Dependency of the sources should be avoided. Further precautions should be taken to enable that all cases included should originate from within the space-time unit under study, with the population assumed to be closed for entries and loses during the defined study period. Both groups should have accurate and comparable results. If the likelihood of capture of the 2 data systems was positively associated the method gave a conservative estimate of the total.

Morse et al in 1999 carried out a study to estimate the total 1995 incidence of arm and hand work related musculoskeletal injury cases and to estimate the incidence of unreported cases relative to cases reported through the State's Workers' Compensation insurance and occupational disease and injury reporting systems (a method identical to

the one for the current seven year review but focused only on MSD in one year).[7] Two samples were compared; 1) Connecticut workers' compensation insurers' reports of arm-hand work injuries not due to acute injury; and 2) work related musculoskeletal injury cases reported to the state Departments of Labor and Public Health via the Physician's Occupational Disease and Injury Reporting System. There were 1,295 unique arm and hand work related MSD injuries reported via both systems in 1995. There was a very small overlap between the two state injury reporting systems: 6.7% for reported workers' compensation cases, and 8% for cases in the physician's occupational disease and injury reports. The maximum likelihood estimate for 1995 CT arm –hand work related MSD not captured by either official reporting system was 13,286 (95% confidence interval 8,332-17,052).

The current study similarly includes the Connecticut Workers Compensation data (WCC) and the occupational disease surveillance data (ODSS) for 1995-2001. The Bureau of Labor Statistics (BLS) data for work related illnesses and injuries, for all seven years starting from 1995 was also available for other analysis.[23, 24, 25] Data received in electronic form was cleaned and standardized. This database included all categories that may be MSD, lung and poison, skin, infectious diseases and other diseases. The workers compensation database was reviewed case by case for recoding based on description of illness combined with codes provided by employer/insurer.

Acute injuries such as contusions, crushing, electric shock, fracture and lacerations, multiple injuries from fall, slip or trip as well as burns to the eyes, foreign matter in eye and lower back pain were eliminated from the ODSS and Workers Compensation database.

Industry was coded by the Connecticut Department of Labor for all databases. The following were differences in the databases (see table on appendix 1); The BLS database requires reporting for all occupational illnesses other than minor conditions (no lost or restricted time).[23, 24, 25] This database includes hearing loss under "Repetitive Trauma".

Workers compensation requires reporting cases with incapacity of One Day or more and some medical cases only get reported voluntarily.

ODSS has relatively small percentage of physicians reporting (95 physicians reported from 36 clinics in 2000)

Data Sources

G1.1 Connecticut Workers' Compensation Data

The employer files reports to the workers' compensation commission either electronically or in paper format. These data for the past seven years starting from 1995 to 2001 include primarily lost-time injuries (cases are required to be reported if they result in lost time, though some non-lost time cases are also reported by insurers). Reports are based upon employers' definitions and compliance with reporting procedures. Incorrect coding of conditions is potentially problematic since report may or may not rely on a written physician's diagnosis, although the specific nature of the injury and part of body affected along with its likely cause was recorded. A new category of injury cause, illness type and illness was created based on the description of injury for all the cases.

G1.2 Occupational Disease Surveillance Data from Physicians (Physicians Reports)

Physicians practicing in Connecticut are required to report known or suspected occupational disease or injury cases of specified types to the State Departments

of Public Health and Labor.[13] Illnesses in the different categories of MSDs, lung, infectious, skin and other illnesses are mandatory inclusions in this reporting system. Reports are sent by physicians to the Connecticut Labor Department, to be coded for industry and occupation and then forwarded to the Department of Public Health for data entry.

G1.3 Comparability of Data Sources

Both sources of data are made of either physicians diagnosed work related illness (or employer perceived work related illness) for the WCC and physician diagnosed work related illness for the physicians report (ODSS data). Although reports should be received from all types of physicians, a greater proportion of reports are from the State's Occupational Medicine clinics and physicians. Connecticut Workers' Compensation report by definition does not include injuries of federal employees or self-employed persons. These cases can occur in the ODSS data however, but they constitute a very small portion of reports. WCC injury reports are principally lost-time cases, as CT statute requires only lost-time cases to be reported by employers to the Workers' Compensation Commission, even if medical bills were paid under compensation insurance plans. The ODSS database contains both lost-time and non lost-time cases.

G1.4 Case Definition and Sample Overlap Determination

Individual text describing cases from the two primary study data sources from 1995 to 2001 were manually reviewed for diagnostic data, the nature and probable cause of injury and the body part affected. Cases were further grouped into MSDs, lung, infectious, skin, and "other" disease categories. Matching of cases was carefully done by year of injury between the two databases for the entire 7 years. To ensure that all potential

matching cases were noted, individual yearly reports for WCC database were compared to adjacent years of the physician database (ODSS), since it is possible that cases may not have been reported to both systems in the same year. To identify potential matches, we used an algorithm comparing similar last names, first names, employer name, nature of injury, date of injury, town of injury, body part and illness type. Different disease descriptions belonging to the same case were taken into account by using hand matching utilizing fields such as listed above and town of residence. Matching across years was limited to not more than one year apart in each direction (three years all together) taking into consideration the date of injury and reporting into both of the systems. The specific type of illness type for matching cases was defined by the physician's diagnosis in the ODSS data if there was a discrepancy concerning the type of work related illness between the two data sources. A match was definite if all the fields were identical and assumed if there were slight discrepancies between descriptions of a case between the two data sources. This was a more conservative approach in order to reduce the estimate for un-captured cases (since a higher proportion of overlapping cases results in a lower estimate of un-captured cases).

G1.5 Limitations

Capture-recapture estimates despite their being useful in epidemiological studies have known limitations. These studies assume that for the data sources, each case has similar ability to be captured ("cathability"). Also, accurate and comparable diagnosis of cases in both data sources is important to these studies. Occupational disease cases definition were very similar but not completely identical, between the WCC and the ODSS data sources. Precise diagnostic information for cases was often lacking when

assessing employers' workers 'compensation reports, whereas diagnosis detail was greater in the physician reporting systems. The proportion of overlapping cases relative to numbers reported to both systems was least for the less specific diagnostic category and thus occupational disease underreporting may have been biased upward. There were greater case overlapping (and less estimated underreporting) for MSDs and the diagnostic categories tendonitis and carpal tunnel syndrome followed by skin conditions and lung/poison. This was not true for infectious conditions with less defined diagnosis since better defined conditions have a higher reporting likelihood, or alternatively could be an artifact of the type of physician specialties that report through the ODSS program. Depending on the number of specialists for specific conditions like MSDs, skin, infectious and lung/poison in the ODSS and if only severe or other specific cases were most likely to be diagnosed and reported (ODSS reports consists of both lost and non-lost time cases while WCC reports only lost time cases) by these providers, then a negative correlation between the two databases could exist resulting in higher estimates of un-captured cases.

The study diagnostic groupings lacked diagnostic precision and was constructed on broad definitions of work related illnesses to achieve better comparability and to improve diagnostic validity for self –reported prevalence surveys [28, 29]

The likelihood of detecting case overlaps between the two sample sources was done by screening adjacent years of the physician's ODSS database for possible diagnostic matches. This strategy compensated for diagnostic bias and increased matching precision, which was important for capture recapture study validity. To further enhance precision, we employed, first, and last name, and other demographic factors to

reduce the problems with misspellings and name changes. It was still possible that the number of true matches were undetected, a potential error which would also further bias our incidence estimates upward.

Capture-recapture analysis assumes equivalent time –space units for source data sets. This can be a problem as occupational diseases tend to have gradual onset and often the process of reporting is slow Further, capture-recapture analysis assumes a reference population closed to losses or entries during the study period. It is possible that some diagnosed occupational illnesses were reported as workers' compensation cases in jurisdictions other than Connecticut. We do not have available estimates to measure potential bias, however we believe this was not likely to represent a large study effect.

Capture-recapture analysis ideally assumes independence of the source samples. In this context, it is likely that occupational diseases diagnosed by Connecticut physicians were more likely to be reported to workers' compensation insurers, hence to some extent, the two source databases were not entirely independent. If present, such a positive correlation between source samples should according to capture- recapture theory, result in an underestimate of un- captured cases.[16, 27] This would bias study outcomes resulting in lower estimates, operating in the opposite direction to the potential biases previously discussed.

Overall, the capture-recapture analysis with two –source data set was subject to several limitations, with potential biases of estimates of unreported cases, and we therefore believed our estimates are best considered as upper bound for the true population values. Despite several limitations on the precision of our estimates, it is difficult to avoid the conclusion that there is considerable underreporting of occupational

diseases in Connecticut. Using the more conservative lower bound 95% confidence interval estimates for example we estimated the total unreported occupational disease cases at 9 times those reported to the Connecticut Workers Compensation Commission. For tendonitis and carpal tunnel syndrome respectively, this lower bound estimate is 4 times and 5 times the number of commission reported cases.

H. Results

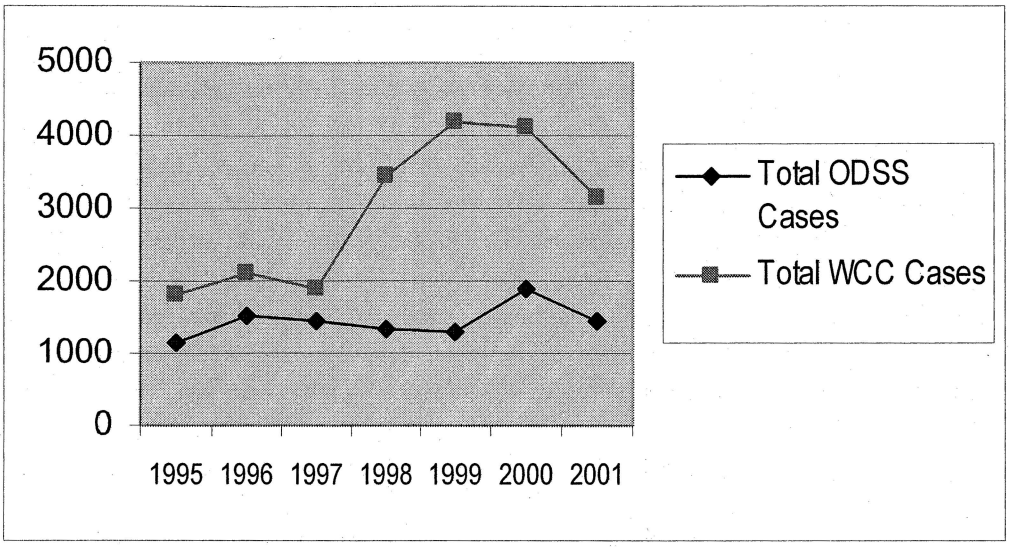
H-1: Combined Database ODSS &WCC, 1995-2001

We had a total of 30,786 cases of occupational illnesses for the entire seven years from the ODSS and WCC databases without adjusting for matches (see section H-4 for overlap of cases between the two data sources). The entire report had only 10,062 (33%) of the cases from the ODSS database (Table H-1.1). There was a steady decrease of reporting of ODSS cases across the years from 1996 except for the year 2000 with 1892 cases and 2001 with 1429 cases respectively (Table H-1.1 and Figure H-1.1). Workers Compensation reports stayed below 2500 cases for the first three years but from 1998 cases increased to above 3000 with more than 4000 cases in 1999 and 2000.

Table H-1.1: Occupational Disease Cases by Database, ODSS & WCC, 1995-2001*.

Cases	Total	1995	1996	1997	1998	1999	2000	2001
ODSS Cases	10062	1151	1527	1442	1319	1302	1892	1429
WCC Cases	20724	1825	2124	1894	3442	4189	4094	3156
Total	**30786**	**2976**	**3651**	**3336**	**4761**	**5491**	**5986**	**4585**

Figure H-1.1: WCC and ODSS Reports across Seven Years*.



* Not adjusted for matching cases reported to both systems (Table H-1.1 &Figure H-1.1)

Musculoskeletal (MSD) disease had the highest proportion of occupational illnesses, with 16,418. (53.3%) cases over the 7 years from both databases (Table H-1.2). There were 4530 lung/poison cases, 4072 cases of infectious disease and 3296 cases of skin conditions. The highest number of cases for all the years was in 2000, a total of 5986 cases (table H-1.2). This increase in reports for the year 2000 was mostly driven by MSD conditions.

Table H-1.2: Occupational disease by Illness, ODSS and WCC Combined*, 1995-2001.

Category	Total	1995	1996	1997	1998	1999	2000	2001
Infectious	4072	323	525	357	581	946	766	574
Lung/Poison	4530	565	506	472	794	629	911	653
MSD	16418	1562	2081	1869	2417	2810	3220	2459
other	2470	277	234	239	433	474	466	347
skin	3296	249	305	399	536	632	623	552
Total	**30786**	**2976**	**3651**	**3336**	**4761**	**5491**	**5986**	**4585**

* Not adjusted for matching cases reported to both systems

The category of "other illness" includes 884 cases of heart/hypertension (including stroke) reported to the WCC compared to only 15 cases reported to the ODSS database. There were also 637 reports of mental stress, 394 cases of hearing loss and 134 cases of heat/cold related conditions in the "other category" reported to the WCC database compared to only 22 mental stress reports, 97 hearing loss reports and 33 heat/cold related conditions reported to the ODSS database. These discrepancies are probably due to the accuracy of physicians' diagnosing of heart and other conditions as opposed to workers and employers inaccurately reporting the same conditions in the WCC claims. Heart and hypertension also differ because there is a legal definition in WCC that defines such conditions in police and fire as work-related-physicians would be looking to see if the job was a significant contributor (if they asked at all for these conditions)[17, 18, 19, 20]. The fact that not all physicians are reporting also support discrepancies in the two databases.[7, 9, 12, 13]

H-2: Workers Compensation First Report of Injury Data

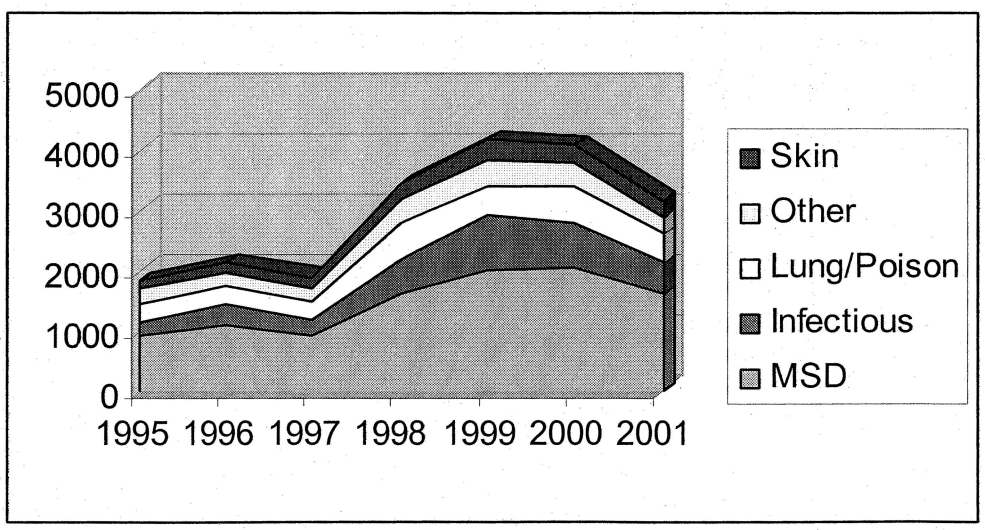
There were a total of 20,724 Workers' Compensation reports for occupational illness for the seven years. The most reported illnesses were MSDs, 10,204 reports similar to ODSS reports were MSDs was the most common condition. This was followed by infectious conditions, with 3,565 reports and lung/poison conditions, with 3,110 reports (table H-2.1, figure H-2.1). Skin conditions had a total of 1650 reports and the "other" category had 2195 reports. Musculoskeletal illnesses increased and stayed high above 1,100 reports starting from 1998 (Figure H-2.1). Infectious conditions also increased and stayed above 500 reports from 1998 compared to prior years. A similar

trend of higher reports of work related conditions from 1998 were noticed for the rest of the conditions (skin, lung/poison, and "other") relative to prior years with fewer reports. Figure H-2.1 also shows a trend of higher reports for all categories compared to prior reports before 1997.

Table H-2.1: Occupational Disease by Type, WCC, 1995-2001

Category	Total	1995	1996	1997	1998	1999	2000	2001
MSD	10204	906	1099	926	1615	1988	2051	1619
Infectious	3565	230	347	239	572	923	739	515
Lung/Poison	3110	303	309	323	596	494	621	464
Other	2195	258	215	207	389	441	395	290
Skin	1650	128	154	199	270	343	288	268
Total	**20724**	**1825**	**2124**	**1894**	**3442**	**4189**	**4094**	**3156**

Figure H-2.1: Occupational Disease by Type, WCC, 1995-2001



Occupational illness reports are a subset of the Workers' Compensation reports that include a much larger number of traumatic injuries. In 2001 for example, 31,863 reports of the WCC data were received in electronic form including traumatic injuries like contusions, crushing, electric shock, fracture, lacerations, hernias, sprain, back problems (lower back) including cumulative injuries, burns, fall, slip and trip.[30]

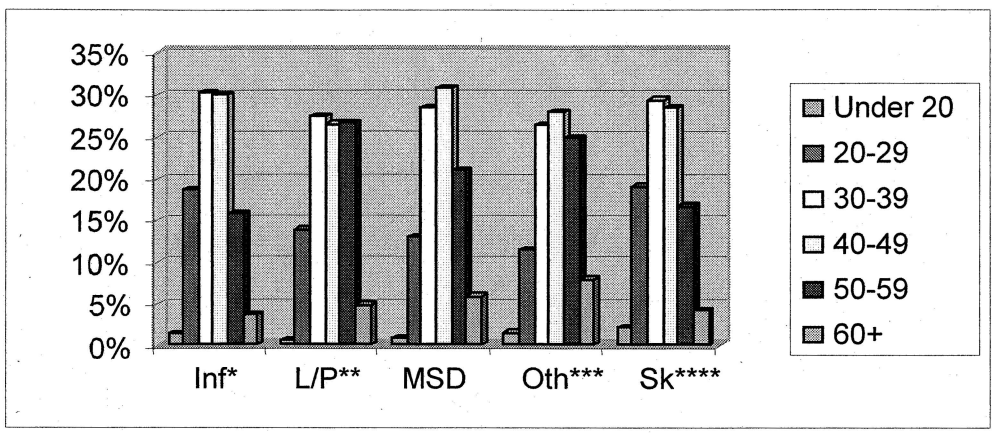
There were 888 cases of heart/hypertension reports (including stroke) in the "other" category. This category also had 637 cases of mental stress, 394 cases of hearing loss and 134 cases of heat/cold related reports.

There were only 7,681 WCC reports with age of workers correctly specified (table H-2.2). The other reports were either left blank or filled as unknown. It is also worth mentioning that there were whole year's reports without ages of workers specified. Occupational illness reports were most common for workers in their 30s and 40s, followed by 50s, 20s, over 60, and ages under 20 years. Lung/poison and "other" conditions did tend to be more common amongst workers in their 50s. Infectious conditions and skin conditions, on the other hand was more prevalent amongst workers in their 20s (Table H-2.2 and Figure H-2.2).

Table H-2.2: Workers' Age in Illness Reports, WCC, 1995-2001

Age	Total	Infectious	lung/Poison	MSD	other	skin
Under 20	82	20	7	32	11	12
20-29	1118	291	157	473	87	110
30-39	2198	474	311	1043	200	170
40-49	2277	470	301	1129	212	165
50-59	1603	248	303	767	188	97
60+	410	58	55	213	60	24

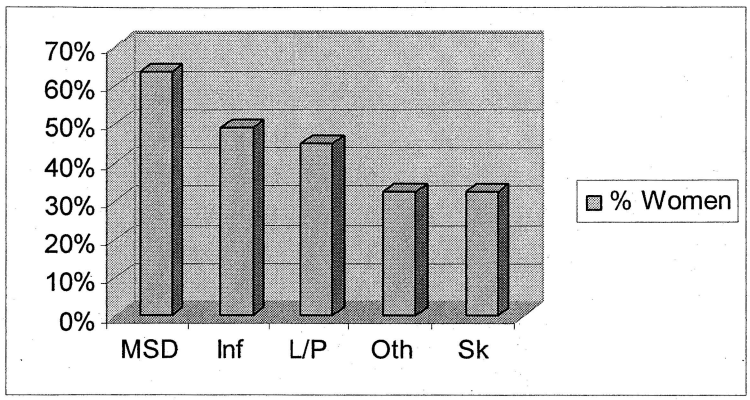
Figure H-2.2: Workers' Age in Illness Reports, WCC, 1995-2001



*Infectious, **Lung/Poison, ***Other, ****Skin

Overall, 8,263 WCC reports had gender specified for workers. Grouped by type of illness (MSDs, lung/poison, infectious reports, skin and other), women consisted of more than half of the reports (52% of cases) (figure H-2.3). As has been shown earlier with MSDs dominating the reports, there were higher proportions of women for MSD, followed by infectious and lung/poison conditions, but relatively lower levels for "other" and skin reports. This can be explained by the fact that women did tend to work more in the service and health care industries thus the high percentage of MSDs and infectious disease cases. One would also expect a high number of cases for skin conditions linked to specific industries like healthcare but with incomplete information on gender an accurate picture of gender, industry sector and type of work related illness can not be depicted.

Figure H-2.3: Percentage of Women by Disease type, WCC, 1995-2001



*Infectious, **Lung/Poison, ***Other, ****Skin

The majority of occupational disease cases for the seven years were in the service sector (Figure H-2.4 and Table H-2.4), with 4,530 (23%) reports, followed by manufacturing: 4361 (21%) cases, the State of Connecticut: 4153 (20%) cases, towns and cities: 2576 (13%) cases. Wholesale/retail trade, finance, insurance/real estate, construction/mining/agriculture, transportation and utilities each had less than 10% of the cases of occupational illness.

Figure H-2.4: Occupational Illness Cases by Industry, WCC, 1995-2001

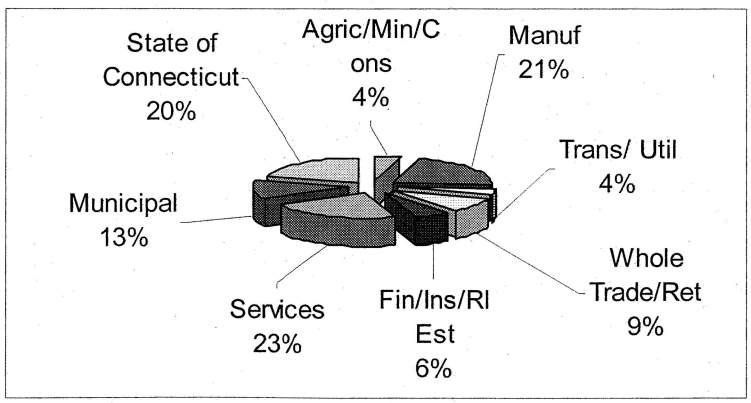


Table H-2.4: Cases of Occupational Disease by Industry Sector, WCC, 1995-2001

Industry Sector	Total	1995	1996	1997	1998	1999	2000	2001
Ag/Mine/Cons*	840	83	101	69	125	192	160	110
Manufacturing	4361	447	509	436	613	760	866	730
Trans/ Util**	836	108	103	74	136	182	110	123
Whole/Retail	1913	204	268	193	293	373	338	244
Fin/Ins/REst***	1213	122	176	122	173	224	234	162
Services	4530	251	582	518	767	1061	847	504
Municipal	2576	277	313	189	293	526	561	417
State of Ct****	4153	300	59	221	1010	848	939	776
Unknown	302	33	13	72	32	23	39	90
Total	**20724**	**1825**	**2124**	**1894**	**3442**	**4189**	**4094**	**3156**

*Agriculture/Mining/Construction
**Transportation/Utilities
*** Finance/Insurance/Real Estate
****State of Connecticut

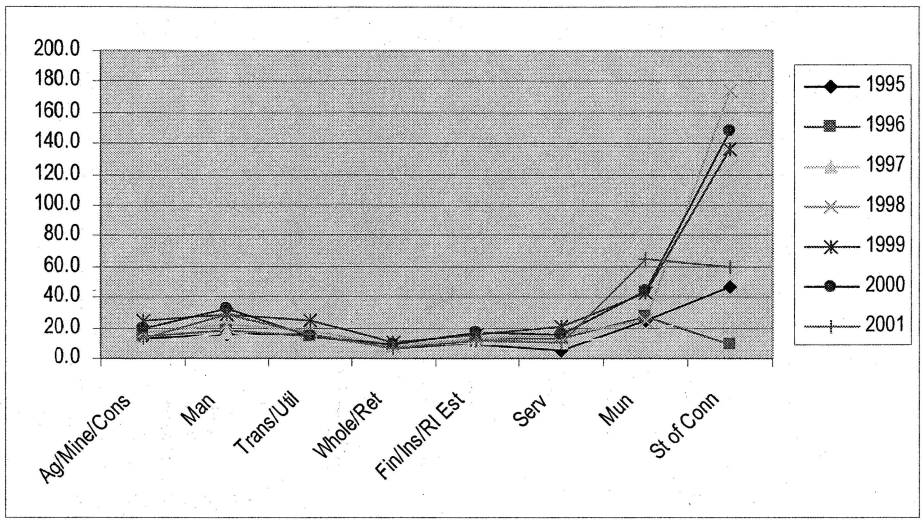
In analyzing the rate per 10,000 workers (by using the employment figures of each sector by year), the State of Connecticut had by far the highest rates across the seven years except for 1996 (Table H-2.5 and Figure H-2.5). Similar high rates though not exactly the same were also found with the municipalities and the manufacturing sector.

Table H-2.5: Rates per 10,000, Industry Sector, WCC, 1995-2001

Industry Sector	1995	1996	1997	1998	1999	2000	2001
Ag/Mine/Cons*	12.7	14.8	8.7	16.4	24.2	19.1	13.2
Man**	16	18.5	16.3	22.2	28.4	33	28.8
Trans/Util***	15.5	14.4	9.8	18.5	24.1	14.2	15.7
Whole/Ret****	6	7.7	5.4	8.2	10.4	9.3	6.8
Fin/Ins/Rl Est*****	9.2	13.5	8.7	12.7	16	16.5	11.4
Serv******	5.5	12.5	9.9	15.3	20.4	15.9	10.9
Mun*******	24.6	27.1	15.3	24.5	42.6	44.1	65.4
St of Conn********	47.2	9.7	35.5	174.4	136.1	147.9	59.4

*Agriculture/Mining/Construction
** Manufacturing
***Transportation/Utilities
****Wholesale/Retail
*****Finance/Insurance/Real Estate
******Services
*******Municipal
********State of Connecticut

Figure H-2.5: Rates per 10,000 of Occupational Disease by Industry Sector, WCC, 1995-2001.



Occupational disease concentrations by industry sector were not identical for the different types of illness (Table H-2.6). Infectious diseases and exposures were more concentrated in the services sector (39%), the State of Connecticut (36%), and the towns and cities (17%). Lung /poison conditions frequently occurred in sectors such as the state of Connecticut (32% of all infectious diseases), towns and cities (17%), services (16%) and manufacturing (16%). Musculoskeletal disorders were most prevalent in the manufacturing (31%), followed by services (19%), wholesale and retail (13%) and State of Connecticut (13%). Skin problems occurred in the service industry (26%), municipalities (18%), manufacturing (17%), State of Connecticut (14%), and Agriculture, mining and construction (9%). The "other" category was prevalent in the municipal (28%), manufacturing (19%), State of Connecticut (16%) and services (14%).

Table H-2.6: Type of Disease by Industry Sector, WCC, 1995-2001

Industry	Inf*	% Inf*	L/P	% L/P**	MSD	% MSD	Other	% Other	Skin	% Skin
Ag/Mine/Cons	69	2%	115	4%	424	4%	82	4%	150	9%
Manufacturing	46	1%	486	16%	3137	31%	408	19%	284	17%
Trans/ Util	62	2%	144	5%	481	5%	73	3%	76	5%
Whole/Retail	63	2%	206	7%	1349	13%	191	9%	104	6%
Fin/Ins/Rl Est	30	1%	112	4%	910	9%	124	6%	37	2%
Services	1376	39%	503	16%	1913	19%	317	14%	421	26%
Municipal	613	17%	523	17%	518	5%	617	28%	305	18%
St of Ct	1274	36%	992	32%	1307	13%	349	16%	231	14%
Unknown	32	1%	29	1%	165	2%	34	2%	42	3%
Total	**3565**	**100%**	**3110**	**100%**	**10204**	**100%**	**2195**	**100%**	**1650**	**100%**

*Infectious, Agriculture/Mining/Construction, Transportation/Utilities, Wholesale and Retail, Finance/Insurance/Real Estate, State of Connecticut.
**Lung/poison

Table H-2.7 shows specific industry sectors (by four digit SIC codes) that reported over 150 cases of occupational illness across the seven years. The State of Connecticut had the highest number of cases (3,563) reports, followed by towns and cities (1,830 reports), hospitals (1,267reports), shipbuilding (563 reports), and nursing homes (507 report). The rest of the industry sectors including schools and doctors' offices had cases fewer than 500 reports. The employment figures for these sectors were noted; sectors employing large numbers of workers were more likely to have higher number of cases.

Table H-2.8 shows the sectors with the highest *rates* of occupational diseases, based on four digits SIC industry codes. Only sectors that had at least 100 cases were shown, since the rates will be unstable with lower numbers <<to be cont'd>>.

Table H-2.7: Industry Sectors with over 150 Cases of Occupational Disease, WCC, 1995-2001.

Industry Sector	SIC	Total	1995	1996	1997	1998	1999	2000	2001
State of Connecticut	9100	3563	297	51	219	1005	844	883	264
Municipal	9000	1830	168	203	166	11	508	446	328
Hospitals	8062	1267	39	93	93	223	395	221	203
Ship Building	3731	563	136	54	43	31	35	94	170
Nursing Homes	8051	507	37	69	49	93	113	108	38
Schools	8211	354	58	75	17	46	22	84	52
Life Insurance	6311	312	48	33	47	57	23	63	41
Aircraft Engine Mfg.	3724	311	29	41	30	21	42	77	71
Amusement and Recreation Services	7999	300	40	71	71	44	10	4	60
Grocery Stores	5411	285	58	61	34	37	43	27	25
Employment Services	7363	268	8	31	17	59	61	47	45
Restaurant	5810	241	22	31	33	41	54	41	19
Health Insurance	6331	228	21	43	16	20	42	45	41
Telephone Comm.	4813	227	60	12	9	14	76	28	28
Department Stores	5311	220	29	52	25	34	28	32	20
Courier Services	4215	186	24	52	21	39	3	19	28
Office Machine Mfg.	3579	172	13	23	23	32	25	42	14
Doctors Offices	8011	163	6	15	16	20	41	37	28

Table H-2.8: Industry Sectors with Highest Rates of Disease, WCC, 1995-2001

Industry Sector	SIC	Empt.	1995	1996	1997	1998	1999	2000	2001	Ave R
St. of Ct*	9100	62,317	47.7	8.2	35.1	161.3	135.4	141.7	42.4	81.7
Mun**	9000	123,600	13.6	16.4	13.4	0.9	41.1	36.1	26.5	21.2
Hospitals	8062	47,649	8.2	19.5	19.5	46.8	82.9	46.4	42.6	38
Nursing Homes	8051	37,417	9.9	18.4	13.1	24.9	30.2	28.9	10.2	19.4
Life Insurance	6311	31,920	15	10.3	14.7	17.9	7.2	19.7	12.8	14
Airc Eng Man	3724	20,166	14.4	20.3	14.9	10.4	20.8	38.2	35.2	22
Grocery Stores	5411	41,634	13.9	14.7	8.2	8.9	10.3	6.5	6	9.8
Empt Serv	7363	32170	2.5	9.6	5.3	18.3	19	14.6	14	11.9
Restaurant	5810	78484	2.8	3.9	4.2	5.2	6.9	5.2	2.4	4.4
Health Insurance	6331	12796	16.4	33.6	12.5	15.6	32.8	35.2	32	25.5
Tel Com	4813	9954	60.3	12.1	9	14.1	76.4	28.1	28.1	32.6
Department Stores	5311	24,222	12	21.5	10.3	14	11.6	13.2	8.3	13
Office Machine Man	3579	5409	24	42.5	42.5	59.2	46.2	77.6	25.9	45.4
Hardware, NEC	3429	4,024	57.2	17.4	34.8	64.6	84.5	52.2	22.4	47.6
Natl Comm Banks	6021	6392	3.1	50.1	4.7	1.6	20.3	51.6	45.4	25.3

*State of Connecticut
**Municipal

Musculoskeletal Disorders (MSDs)

Musculoskeletal disorder is the currently used term for conditions also known as cumulative trauma disorders or repetitive strain injuries.[3, 13, 17,]

MSDs accounted for 10,204 cases, which was almost half (49.2%) of the occupational diseases reported to Workers' Compensation (Table H-2.9).

Table H-2.9: Musculoskeletal Disorders by Type, WCC, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
CTS	3083	281	307	383	431	560	657	464
Other MSDs	4361	407	619	6	1044	754	888	643
Pain/Inflammation	1896	151	30	421	23	547	323	401
Tendonitis	616	56	118	93	91	73	116	69
Ganglion	140	7	8	9	14	35	40	27
Epicondylitis	108	4	17	14	12	19	27	15
Total	**10204**	**906**	**1099**	**926**	**1615**	**1988**	**2051**	**1619**

Carpal Tunnel Syndrome (CTS) was the most common specific diagnosis with 3083 cases reported or 30.2 percent of total MSD reports (see Table H-2.9).

The "other" category of MSDs, with a total of 4361 cases or 42.7% of reports included nerve-related problems (with symptoms of numbness or tingling), hand arm vibration syndrome (HAVS), plantar fascitis, rotator cuff syndrome, thoracic outlet syndrome, and trigger finger. Pain and Inflammation had 1896 cases, or 18.6% of reports and included cases of arthritis, bursitis and swelling, tendon –related problems included 616 cases of tendonitis and 108 cases of epicondylitis. There were 140 cases of ganglion or cysts (Table H-2.9). Three thousand and ninety-three cases did not have a specific description other than "strain or sprain" (this category did not include acute strains or sprains), "Pain," "swelling" or no description.

The specific body parts associated with illness conditions were not stated for all the cases. In addition to this, body part codes were not always possible to interpret (as a general rule, cases either had a specified body part or multiple parts, or a specified code pertaining to a body part, or multiple parts). In all, 8837 cases had specified body parts with the majority of cases having unspecified body part. Almost all the cases of MSDs with assigned body part or parts were in the upper extremity of the body. More than half

of the MSD cases with assigned body part/ parts (5965 cases), were associated to the hand, wrist, and the lower arm (Table H-2.10). Other affected parts of the body included, 812 cases of the upper arm, shoulder, and upper extremity, 808 cases of multiple body parts, and 739 cases of the elbow. There were 349 cases affecting the legs, knees and feet as well as 164 cases associated to the neck and upper back. It is worth noting that reports of lower back cases, even if they indicated that they were injuries caused by cumulative trauma, were not included in this analysis. This is because the cause of lower back injuries is difficult to determine based on the reports in the database; acute injury and cumulative trauma disorders can both lead to lower back problems.

Table H-2.10: Musculoskeletal Disorders by Part of Body, WCC, 1995-2001

Body Parts	Total	1995	1996	1997	1998	1999	2000	2001
Lower Arm, Wrist, Hand	5965	506	656	648	977	1182	1131	865
Upper Arm, Shoulder, Upper Extremity	812	83	92	85	135	141	139	137
Multiple Body Parts	808	38	57	64	100	165	205	179
Elbow	739	52	74	61	127	159	155	111
Legs, Knees, Feet	349	32	31	3	83	80	53	67
Neck and Upper Back	164	17	28		37	33	26	23

Causes of conditions were often incomplete and were not consistently coded or described. Approximately half of MSD cases had enough description to show some cause. Of the MSDs that could be assigned a specified cause, the most frequently mentioned cause was "repetition" (2953 cases), although this was frequently used to describe any chronic musculoskeletal problem (Table H-2.11). This was followed by 1136 cases of computing and clerical tasks that included typing, keying, mouse use,

phone use, etc. There were 610 cases with cause mentioned as tools; including pneumatic tools that have been associated with vibration exposure as well as biomechanical risks. Lifting was specifically mentioned as a causal mechanism in 481 cases, followed by use of various forms of machines (237cases), assembly work (134 cases), and pushing or pulling action (124 cases). Other causal mechanisms with 30 or more reports but less than 100 cases included walking/standing /carrying, kneeling, driving, and gripping. These mechanisms resulted in workers adopting awkward postures and static postures with the resultant development of MSDs by workers.

Table H-2.11: Musculoskeletal Disorders by Cause, WCC, 1995-2001

MSD Cause	Cases
Repetition	2953
Computer and Clerical	1136
Tools	610
Lifting	481
Machine	237
Assembly	134
Push/Pull	124
Walking/Standing/carrying	71
Kneeling	55
Driving	53
Gripping	33

Infectious Diseases/Exposures

Infectious disease reports included both actual disease and exposure to potentially infectious agents. Recent court decisions have broadened the definition of compensable disease to include exposures, particularly where exposures require medical treatment such as prophylactic treatments for conditions like tuberculosis (TB), AIDS (HIV) and recently anthrax exposures. There has recently been considerable attention paid to Lyme disease among outdoor workers, resulting in an increased frequency of reporting tick bites. It is

often difficult to determine whether the first report of injury was actual disease or only exposure (for example, actual Lyme disease or only a report of a tick bite). Similarly, it is usually not clear in the reports for needle stick and sharp injuries whether the source patient or client was actually infected with any of the known bloodborne diseases. There were additional reports of exposure to "sputum" or "spit" that are not reported here, since risks tends to be low from such exposures.

Table H-2.12: Infectious Illness and Exposure by Type, WCC, 1995-2001

Illness/Exposure	Total	1995	1996	1997	1998	1999	2000	2001
Bloodborne	1772	26	147	136	358	518	351	236
Tuberculosis/PPD Conversion	532	32	57	51	84	92	80	136
Lyme Disease/Tick Bite	369	17	30	4	62	109	94	53
Human Bite/Urine	286	7	38			120	85	36
Other Infectious	606	148	75	48	68	84	129	54
Total	**3565**	**230**	**347**	**239**	**572**	**923**	**739**	**515**

Bloodborne diseases or blood exposures were the most common infectious disease category reported, with 1772 cases compared to only 286 cases of human bites or exposures to body fluids such as urine (Table H-2.12). Diseases that can be contracted through blood include hepatitis B, C and HIV/AIDS. Transmission is much less likely when a worker is exposed to urine or human bite than transmission occurring from blood, particularly for HIV. Blood to blood exposure has the highest risk, and often occurs from needlesticks or sharp injuries.[14]

Tuberculosis/PPD conversion cases were the next most common, with 532 cases reported. There were in all 369 reports of tick bites, rashes from tick bites, and Lyme disease cases attributed to occupational exposures. The "other" category of infectious

diseases had 606 reports, including scabies reports, chicken pox, anthrax exposure, meningitis, rabies and shingles reports.

Of the 1772 bloodborne exposures, 825 (46.6 %) specifically mentioned needlesticks or other sharps exposures. The remaining cases tended to be skin exposures to blood (though often not clearly identified) or not stated all together. It is not known how many of these blood exposures were from patients or clients who had infectious diseases. Possible exposure to bloodborne diseases through needlesticks has received increased attention recently because of the November, 2000 Needle-stick Safety and Prevention Act passed by Congress.[14]This revises the OSHA Bloodborne Pathogens Standard that went into effect in April of 2001. The Needle-stick Act emphasizes safe needle device use and requires a separate injury log for recording needles and other sharps incidents.

Acute and Chronic Lung Conditions

There were a total of 3110 cases of lung conditions that included acute respiratory/poisoning cases and chronic lung diseases both work place exposures (Table H-2.14). Because descriptions vary, and data on causes of lung conditions were incomplete, specific etiologies of lung conditions were difficult to precisely classify. Smoke exposures and chemicals were the most common source of acute respiratory/poisoning conditions. Other causes were gases (including fumes from vehicles, natural gas, and similar sources), Indoor Air Quality problems, dust (frequently from construction sites), carbon monoxide, solvents, mold, construction and fiberglass (Table H-2.13).

Table H-2.13: Causes of Acute Respiratory Conditions

Cause	Cases	Percent
Smoke/Fumes	688	25%
Chemicals	681	25%
Gases	178	6%
Indoor Air Quality	106	4%
Dust	98	4%
Carbon Monoxide	71	3%
Solvents	50	2%
Mold	37	1%
Construction	25	1%
Other -Miscellaneous	823	30%
Total	**2778**	**100%**

Chemical exposures included fiberglass, mercury, lead, perfume, asphalt, metal working fluids/oils, glue /adhesive, acids, ethylene glycol, insecticides, latex, ozone, ammonia, formalin, glycol ether, pepper spray, and welding fumes. Lead poisoning cases were not significant because most of the lead cases are included in the laboratory blood lead levels reports.

Table H-2.14: Acute and Chronic Lung Diseases by Type, WCC, 1995-2001

Illness	Cases	Percent
Respiratory/Poison (Acute)	2476	80%
Asbestos Exposure/Other	237	8%
Asbestos Disease	74	2%
Asthma	188	6%
Other Chronic Lung	135	4%
Total	3110	100%

Chronic lung conditions included asbestos-related diseases and exposures, occupational asthma, and other chronic lung conditions. Acute lung problems were classified under respiratory disease category. Latex allergies are often related to lung effects and were classified as allergies under "other chronic lung".

There were 237 asbestos exposure and related conditions as well as 74 cases of asbestosis (asbestos disease), (Table H-2.14). Asbestos is known to increase the risk of lung disease and cancer. If disease occurs as a result, it often appears between 10-40 years after exposure. Asthma cases were attributed to indoor air quality, mold, smoke, cleaning and other chemicals, construction and dust, Freon, pepper, spray, perfume, and running. Other chronic lung diseases included pneumonia, emphysema, chronic obstructive pulmonary Disease (COPD), bronchitis, hypersensitivity pneumonitis, sick building syndrome (SBS), reactive airway disease syndrome (RADS), Pneumoconiosis including beryliosis, and silicosis.

Skin Conditions

There were a total of 1650 skin conditions reported for the seven years report (Table H-2.15). Exposure to poison ivy/oak and other plants (such as tobacco leaves) were the most common causes reported. This was followed by chemicals, gloves or latex exposure. Chemicals specifically mentioned in relation to skin disease included glue, adhesive, asphalt, fiberglass, formaldehyde, gluteraldehyde, ink, iodine, moisture, paint, photographic chemicals, polymer, sheetrock, thallium bromide, solvents and detergents.

Table H-2.15: Skin Disease by Type, WCC, 1995-2001

Cause type	Total	1995	1996	1997	1998	1999	2000	2001
Poison Ivy/Plants	614	38	43	39	105	132	128	129
Chemicals/Latex	329	20	7	16	72	62	82	70
Other /Unknown	706	70	104	144	93	149	75	72
Total	**1650**	**128**	**154**	**199**	**270**	**343**	**285**	**271**

Other Occupational Diseases

Heart and Hypertension

There were 888 cases involving heart conditions, stroke, or hypertension reported across the seven years (Table H-2.16). These conditions were specifically mentioned as heart attacks, angina, or emergency care for heart/chest pain, hypertension (or heart and hypertension benefits) and stroke. Though not generally well described, causes included physical exertion: lifting and unloading, running to stop an altercation, firefighting, agricultural work, lawn maintenance, climbing stairs, patient care, and working as a waitress.

Stress was also mentioned caused by: meeting with a principal, excessive overtime and shift work, a "confrontation with a boss" and verbal harassment from a co-worker. A couple of cases described "normal job duties," and sedentary activity such as sitting or standing.

Mental Stress

There were a total of 637 stress-related claims (Table H-2.16). The majority of these reports appeared to be "mental-mental" claims: mental stress resulting in mental illness which was not covered by Workers' Compensation in Connecticut since a statutory change in1993. Cases were caused by supervisor or co-worker relations or harassment, violence or threats, excessive job demands and overtime. Other reports included being trapped in an elevator, fear of dogs, post-traumatic stress disorder, "voodoo curse by a prisoner" and anxiety attacks.

Hearing Loss

There were 394 cases of acute and long term hearing loss (Table H-2.16). The major causes of acute hearing loss were loud sounds including electrical impulses on phones and paging systems, gunfire, sirens, slap of a clipboard on a counter, student shouting in an ear, backfires, and an air horn.

Temperature

There were 134 cases of temperature-related problems classified as heat/cold (Table H-2.16). Causes for conditions included firefighting, operating a fried dough booth, and emptying refuse containers. Other causes included working outdoors or heat exhaustion from over-activity.

Table H-2.16: Other Occupational Diseases, WCC, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
Heart/Hypertension/Stroke	888	78	99	70	183	195	176	87
Mental Stress	637	88	67	89	114	101	93	85
Hearing Loss	394	64	19	24	50	67	66	104
Heat/Cold	134	23	20	21	19	31	17	3
Total	**2053**	**253**	**205**	**204**	**366**	**394**	**352**	**279**

As a whole heart/hypertension/stroke conditions were high above 100 reports for each of the year from1998 to 2000 and stayed below 100 for reports of the rest of the years (Table H-2.16). Mental stress reports also had most of the years' reports under 100 cases except for the year 1998 and 1999 with 114 and 101 cases. Hearing loss reports on the other hand were above 50 cases for all the years except for 1996 and 1997 with 19 and 24 reports respectively Heat/cold cases did not attain a total of 40 cases for either of the seven years. There were other diseases like cancer and reports of chemical exposures with poorly defined health effects such as nasal ulcer from chromium exposure, chronic

fatigue syndrome, dental effects from a corrosive chemical and cases of decompression illness from diving, fibromyalgia, and neuroma.

There were 66 cases of allergy reports with sources including reactions to hepatitis immunizations, cleaners, fertilizers, food, metal working fluids, seafood odor, clothing, and latex.

H- 3. Occupational Disease Surveillance System (Physicians' Report)

Physicians are required to report known and suspected occupational disease to the Occupational Disease Surveillance System (ODSS) that is maintained by the Departments of Labor and Public Health (CGS19a-215; Connecticut Public Health Code Sec. 19a-36-A2 through 19a-36-A2 through 19a-36-A5, inclusive) [13]Although all physicians are required to report to this system, most reports are received only from occupational health clinics, auxiliary occupational health clinics, and industrial medicine programs. These report trends, therefore, should be considered as a portion of physician diagnosed occupational diseases in Connecticut. In the year 2000 for example, only 95 physicians from 36 clinics reported at least one case into the ODSS system (an increase of 12 physicians from 1999), five clinics contributed to 59 percent of cases and only ten clinics contributed 75 % of cases .[14, 15]

There were a total of 10,062 cases of physicians' reports for the seven years. According to physicians the exposures causing most of the occupational diseases were classified as either continuing, where workers are exposed to similar hazards or in terms of low, moderate, and high certainty (in terms of a direct causal relationship).

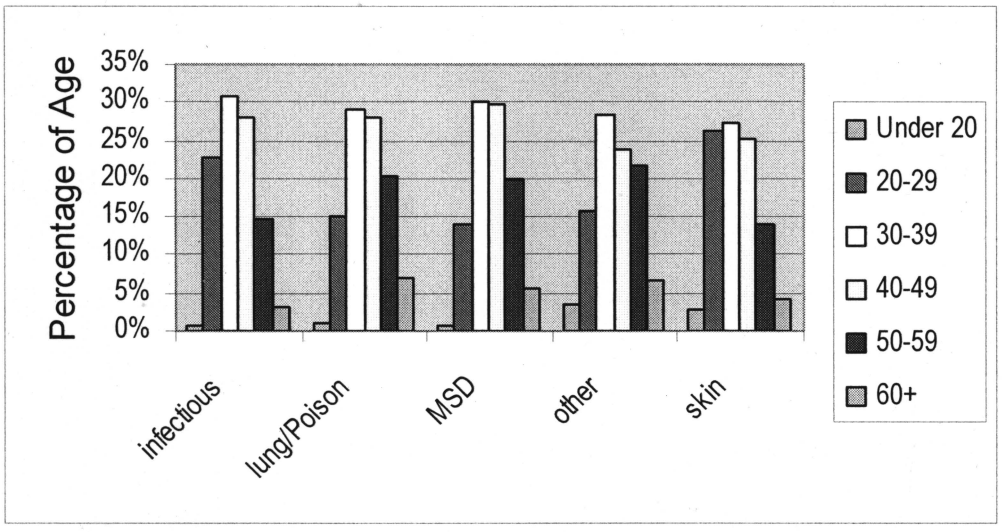
There were only 7352 reports that included the age of the affected worker (Table H-3.1). Based on this number, most work-related illnesses were reported in workers in

their 30s and 40s for all the different class of occupational disease type (Table H-3.1 and Figure H-3.1). Infectious and skin conditions did tend to be most common for workers in their 20s. Workers in their 50s seemed to have a greater proportion of cases in the lung/poison, MSDs and "other" category relative to the infectious and skin category (Figure H-3.1). There was a higher proportion of lung/poison, followed by "other", and MSDs, respectively compared to the skin and infectious category of illnesses in workers above 60 years.

Table H-3.1: Occupational Disease type by Age Range, ODSS, 1995-2001

Age	Total	infectious	lung/Poison	MSD	other	skin
Under 20	90	2	12	28	8	40
20-29	1235	66	167	612	37	353
30-39	2159	90	322	1310	67	370
40-49	2084	82	311	1293	56	342
50-59	1385	43	226	877	51	188
60+	399	9	77	242	16	55
Total	**7352**	**292**	**1115**	**4362**	**235**	**1348**

Figure H-3.1: Occupational Disease Type Percent of Age Range, ODSS, 1995-2001



There were 10,031 reports with identified gender for the different types of occupational disease category (Table H-3.2). Overall there were 5279 reports of occupational disease (53%) for women (Table H-3.2).

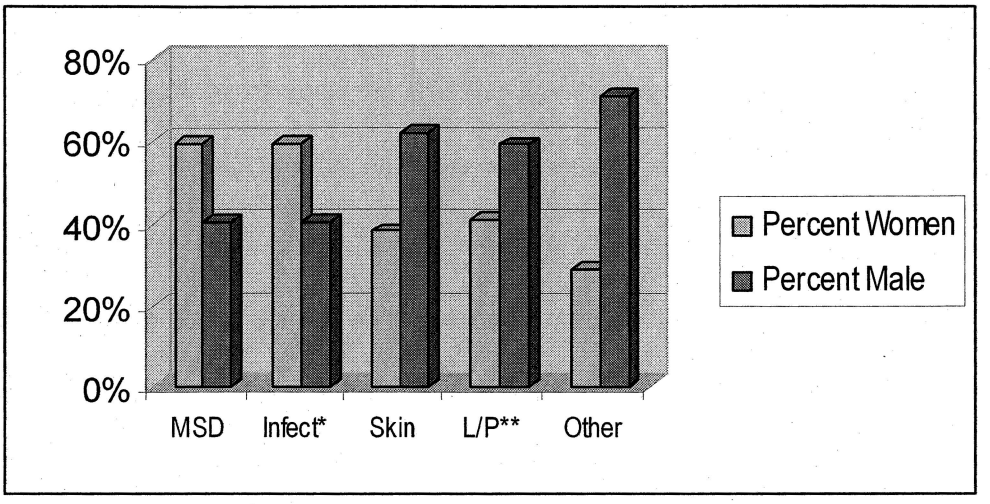
A greater proportion of women had MSDs and infectious disease, followed by lung/poison, and skin conditions (Figure H-3.2). This may be because there are more women employed in the service and healthcare industry where these conditions are more common, although this cannot be determined without the actual employment figures [23, 24, 25]

Men, on the contrary, had a higher proportion of reports for skin, lung/poison and "other" category.

Table H-3.2: Occupational Disease Type by Gender, ODSS, 1995-2001

Illness	Women	Male	Total	Percent Women	Percent Male
MSD	3695	2499	6194	60%	40%
Skin	625	1017	1642	38%	62%
Lung/Poison	578	837	1415	41%	59%
Infectious	302	205	507	60%	40%
Other	79	194	273	29%	71%
Total	**5279**	**4752**	**10031**	**53%**	**47%**

Figure H-3.2: Occupational Disease by Type Percent by Gender, ODSS, 1995-2001



*Infectious ** Lung/Poison

Musculoskeletal conditions made up most of the cases of occupational disease across the seven years (Table H-3.3 and Figure H-3.3). This was followed by skin conditions, lung/poison and infectious conditions. Figure H-3.3 shows a rise and slight fall trend in MSD cases during the period from1995 to 1998. Thereafter, MSD reports increased progressively in small numbers except in the year 2000 when there was a sharp increase in MSD cases and the overall reports.

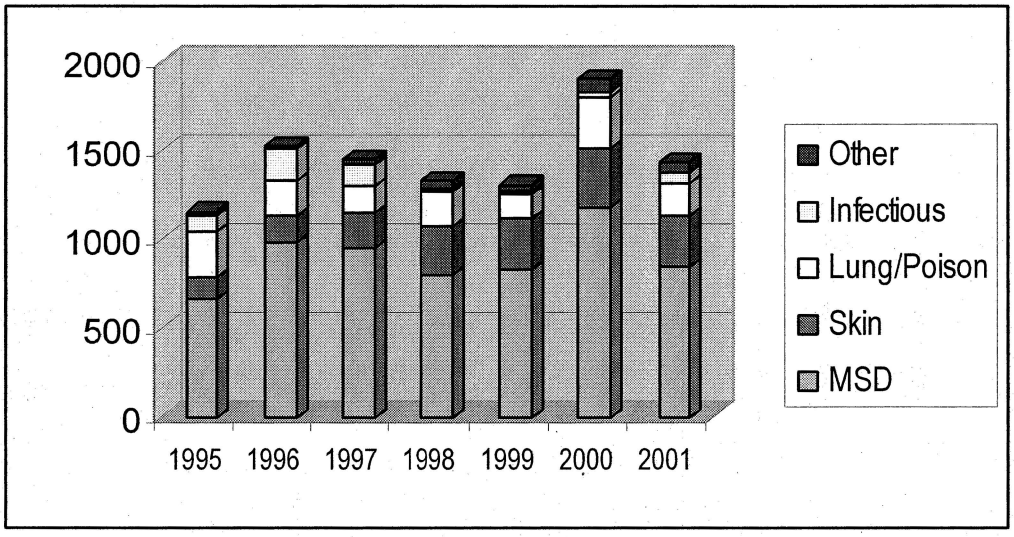
There was a constant increased trend in skin conditions except in 2001 with a slight drop.

Lung/poison reports decreased progressively from 1995 to 1997 but from 1998 reports had a fluctuating trend with peaks and troughs in alternating years.

Table H-3.3: Occupational Disease by Type, ODSS, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
MSD	6213	656	982	943	802	822	1168	840
Skin	1647	121	151	200	266	289	336	284
Lung/Poison	1420	262	197	149	198	135	290	189
Infectious	507	93	178	118	9	23	27	59
Other	275	19	19	32	44	33	71	57
Total	**10062**	**1151**	**1527**	**1442**	**1319**	**1302**	**1892**	**1429**

Figure H-3.3: Occupational Disease by Type, ODSS, 1995-2001



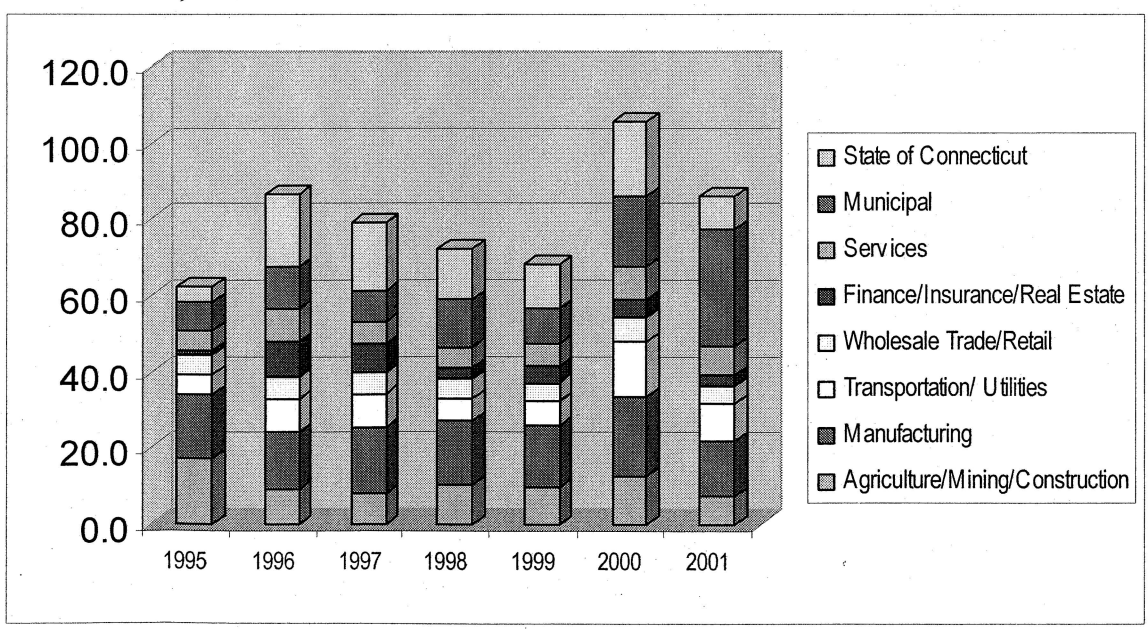
The State of Connecticut, manufacturers, and municipalities had higher rates of occupational disease compared to the other industry sectors (Table H-3.4 and Figure H-3.4). There was a general decrease in rate trend for the State of Connecticut from 1996 except for the year 2000 with a high rate of 19.4 and the low rate of 4.1 for 1995 although individual rates for different years were high (Figure H-3.4). It is also worth noting that rates per 10,000 for the manufacturing sector stayed at a high value above 14.0 across the years. These high rates for the manufacturing, municipal and state industries could be explained by a decrease in employment figures for these sectors across the years. The

service, wholesale and trade industries had smaller rates across years probably due to increase in employment figures for this sectors. Trends in rates, should adjust for employment rates but the trends differ between WCC and ODSS, such as for State of Connecticut claims. It should also be noted that since ODSS is dependent on a small number of reporting physicians, the rates would not be as stable as for WCC—that is, a change in the number of physicians reporting could have a big impact on the rates.

Table H-3.4: Rates per 10,000, Occupational Disease by Industry Sector, ODSS, 1995-2001

Industry	1995	1996	1997	1998	1999	2000	2001
Agriculture/Mining/Construction	17.5	9.4	7.9	10.5	9.9	12.8	7.5
Manufacturing	16.4	14.7	17.2	16.5	16.1	20.7	14.6
Transportation/ Utilities	5.5	9	9.1	5.7	6.5	14.5	9.4
Wholesale Trade/Retail	5.3	5.7	5.6	5.1	4.7	6.3	4.7
Finance/Insurance/Real Estate	1.1	9.2	7.3	3.2	4.5	4.8	3
Services	4.8	8.4	5.9	5.3	5.6	8.2	7.3
Municipal	7.6	10.9	7.8	12.5	9.4	18.7	30.6
State of Connecticut	4.1	19.4	17.8	13	11.6	19.4	8.8

Figure H-3.4: Rates per 10,000, Occupational Disease by Industry Sector, ODSS, 1995-2001



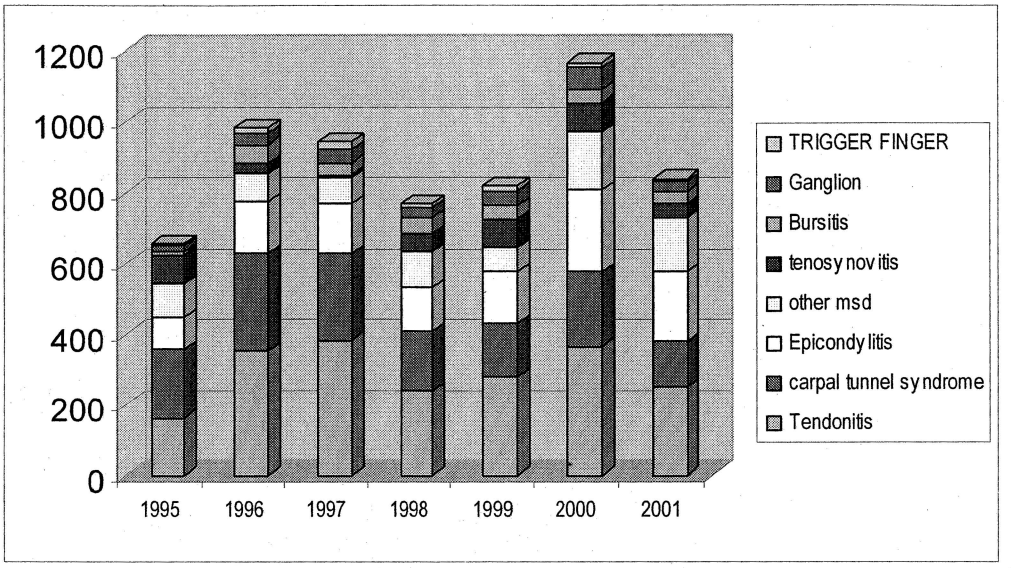
Musculoskeletal Disorders

Musculoskeletal disorders (also referred to as cumulative trauma disorder or repetitive strain injury) include tendon related conditions, nerve problems, circulatory as well as combined conditions. Table H-3.5 includes upper-extremity MSDs, and excludes lower back diagnosis, even if caused by cumulative strain. Tendonitis had the highest number of reports across the years except for 1995 (Table H-3.5). Carpal Tunnel Syndrome reports were second, except for the year 2000 and 2001 with higher reports for epicondylitis than CTS. Epicondylitis was third in the number of MSD reports. Figure H-3.5 shows a double rising trend for tendonitis from 1995 to 1997 and from 1998 to 2000. Carpal Tunnel Syndrome on the other hand rose between1995and 1996 and thereafter declined except for the year 2000 when there was an increase in the number of CTS reports. Epicondylitis increased between 1995 and 1996. This was followed by a fluctuating trend every two years for the rest of the years.

Table H-3.5: Musculoskeletal Disease by Type, ODSS, 1995-2001

MSD	Total	1995	1996	1997	1998	1999	2000	2001
Tendonitis	2034	164	351	383	239	279	367	251
Carpal tunnel syndrome	1380	193	277	247	168	152	212	131
Epicondylitis	1072	92	145	139	126	145	231	194
Other MSD	763	96	79	74	99	68	163	152
Tenosynovitis	372	80	29	7	51	82	81	42
Bursitis	253	10	55	35	48	38	35	32
Ganglion	241	17	31	35	26	42	62	28
Trigger finger	94	4	15	23	12	14	16	10
Total	**6209**	**656**	**982**	**943**	**769**	**820**	**1167**	**840**

Figure H-3.5: Musculoskeletal Disease by Type, ODSS, 1995-2001



Tendon disorders included: Swelling of the tendons (tendonitis), tendon irritation in the elbow area, including "golfer's elbow" and "tennis elbow" (epicondylitis), tendonitis in the elbow area, rotator cuff syndrome, inflammation of the tendon sheaths, lubricated covers that surround the tendons, particularly in the hand (tenosynovitis), tendon sheath disorder of the side of the wrist and base of the thumb (De Quevain's Syndrome), a bump on the tendon that catches on the tendon sheath that makes the finger or thumb difficult to move (trigger finger), swelling of the tendon sheaths from excess lubricating fluid (ganglion cysts), and inflammation of the fluid-filled sacs around ligaments and tendons (bursitis).

Nerve disorders included: pinching of the median nerve in the wrist (carpal tunnel syndrome), usually caused by swollen tendons that pass through the carpal tunnel (the median nerve can also be pinched in the elbow, shoulder and neck areas) and pinching of the ulner nerve in the elbow (cubital tunnel syndrome).

Circulatory/combined/other MSD cases included: pinching of the nerves and blood vessels in the neck/shoulder area (Thoracic Outlet Syndrome), finger blanching from the cut off of blood flow due to vibration (also known as vibration white finger, Raynaud's Syndrome or HAVS, Hand Arm Vibration Syndrome), and swelling of the tissue under the skin in the bottom of the foot (plantar Fasciitis).

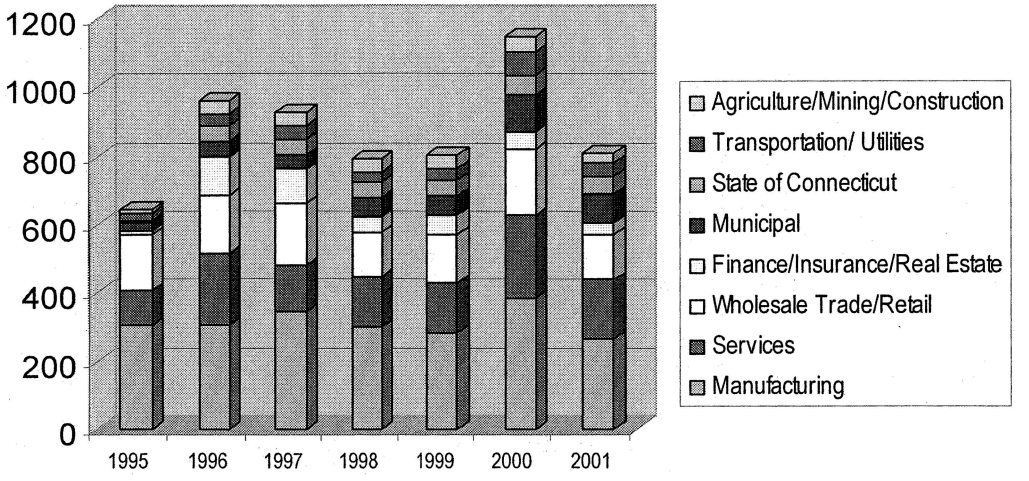
MSD reports were most common in the manufacturing, services (including schools and health care, even if run by state or local government), wholesale, retail and trade industries, municipalities and the State of Connecticut. These industry sectors involved a lot of repetitive work and awkward postures as well as computer use through clerical services (Table H-3.6 and Figure H-3.6).

Table H-3.6: Musculoskeletal Disease by Industry Sector, ODSS, 1995-2001

Industry	Total	1995	1996	1997	1998	1999	2000	2001
Manufacturing	2189	305	307	345	299	283	384	266
Services	1164	105	211	136	148	149	242	173
Wholesale Trade/Retail	1109	163	168	179	133	142	193	131
Finance/Insurance/Real Estate	412	12	114	101	40	55	52	38
Municipal	413	22	42	43	60	56	109	81
State of Connecticut	292	7	44	45	43	46	55	52
Transportation/ Utilities	270	21	37	40	29	32	69	42
Agriculture/Mining/Construction	238	10	37	36	41	40	46	28

Figure H-3.6 shows an increased trend of MSDs in the manufacturing sector from 1995 to 1997. This trend was reversed thereafter except in the year 2000 that had a general rise in all illness categories irrespective of MSDs except for infectious conditions (Table H-3.3). The number of MSD cases stayed high in the manufacturing, service, trade industries which are high risk industries and have high employment.

Figure H-3.6: Musculoskeletal Disease by Industry Sector, ODSS, 1995-2001



Specific industries with a total of over 35 MSDs reported are shown in Table H-3.7. These included hospitals, hospital equipments, catalog and mail order houses, life insurance, municipalities, grocery stores, municipalities, nursing homes, amusement and recreation services, ship building, aircraft engine manufacturing, commercial printing, and the State of Connecticut. Almost all of these industries have been on the list across the seven years. Note should be made that some of these industries include Connecticut's largest employers. Because of the higher employment, larger employers and sectors are likely to have more reported cases.

Table H-3.7: Specific Industries with 36 or More MSDs Reported, ODSS, 1995-2001

Industry	SIC	Total	1995	1996	1997	1998	1999	2000	2001
Hospitals	8062	426	21	63	65	72	65	86	54
Hospital equipment	3841	376	104	88	79	51	27	12	15
Catalog and Mail Order Houses	5961	361	87	67	66	45	30	39	27
Life Insurance	6311	293	6	100	88	27	33	36	3
Municipalities	9000	258	11	31	20	20	37	83	56
Grocery Stores	5411	215	16	27	32	22	29	57	32
Nursing Homes	8051	209	15	30	22	24	20	63	35
Amusement and Recreation Services	7999	140	19	53	1	3	22	23	19
Ship Building	3731	74	27	14	14	5	12	2	
Aircraft Engine Manufacturing	3724	69	8	3	25	12	9	6	6
Commercial Printing	2759	65	2	4	4	2	16	20	17
State of Connecticut	9100	57			1		10	25	21
AEC Equipment Manufacturing*	3621	36	1				1	27	7
Pub Building/ Furniture Manuf**	2531	36		4	1	1		22	8

*AEC (Automotive Electronic Equipment Manufacturing)
**Public Building and Furniture Manufacturing

Since occupational descriptions vary by the person noting them, occupations are difficult to assess; however, several occupations were consistent for MSDs across the years. These included clerical workers and computer operators, assembly workers, health care workers such as nurses and aides, machinists and machine operators, drivers, factory workers, laborers, supervisors and managers.

The most common causes noted for MSD were "repetitive motion", lifting, overuse, computer use and data entry, hand tool use, pushing or pulling, gripping, use of machines, clerical work (specifically computer work) and kneeling, standing or awkward posture. "Repetitive motion" and "overuse" tend to be common terms to describe MSD disorders, so may not clearly indicate a cause.

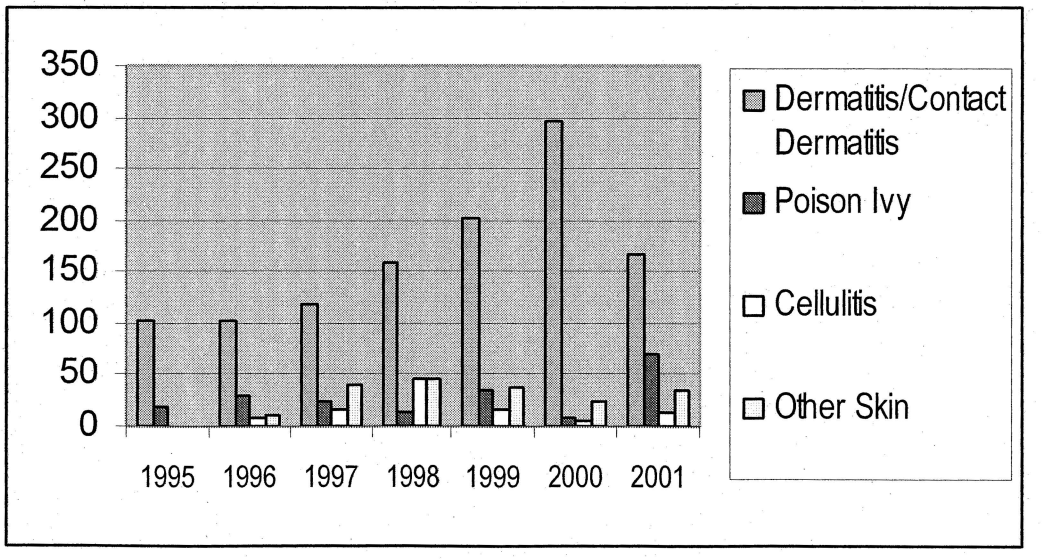
Skin Conditions

There were a total of 1647 reports of skin conditions across seven years (Table H-3.8 and Figure H-3.8). The bulk of skin conditions were reported as either dermatitis or contact dermatitis. This was followed by poison ivy conditions and cellulitis. Figure H-3.8 shows an increasing trend of dermatitis and contact dermatitis except for 2001 with a decrease.

Table H-3.8: Skin Conditions by Illness Type, ODSS, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
Dermatitis/Contact Dermatitis	1144	102	102	118	158	201	296	167
Poison Ivy	200	19	29	25	14	35	9	69
Cellulitis	105		8	16	47	15	6	13
Other Skin	198		12	41	47	38	25	35
Total	**1647**	**121**	**151**	**200**	**266**	**289**	**336**	**284**

Figure H-3.8: Skin Conditions by Illness Type, ODSS, 1995-2001



Poison ivy also causes contact dermatitis, but the separation from contact dermatitis in this work is based on the causes of contact dermatitis (chemicals, latex

versus plants poison ivy and poison oak), and for the purpose of description. It is also possible that some of the contact dermatitis cases were due to poison ivy but classified as contact dermatitis. The "other" category of skin reports consisted of conditions such as scabies, folliculitis, paronychia, and other fungal skin conditions including ringworm.

The most common causes of skin conditions were chemicals, poison ivy and other plant exposures, latex and gloves, fiber glass, oils and lubricants. Specific chemicals mentioned included solvents, epoxy, sulfur, adhesives, lanolin, methylene chloride, oven cleaner, concrete, isopropyl alcohol, and resin.

Skin conditions occurred most commonly in services that included many outdoor occupations, manufacturing from (chemical exposure and tool handling) and towns. There were also a high prevalence of cases from the agricultural sector from exposure with plants and pesticides as well as from the retail, whole sale and trade sector.

Lung Diseases

The most commonly reported lung conditions were acute respiratory disease typically caused by exposure to chemicals or fumes followed by asthma cases (Table H-3.9). Asbestosis and asbestos related conditions had 113 total cases, including 70 from exposure to asbestos and 43 cases of asbestosis. There were 28 cases of pleural plaques included in the 43 asbestosis cases. The other category included cases of RADS (reactive airway disease syndrome), multiple chemical sensitivity, bronchitis, sarcoidosis, sick building syndrome (SBS), and pneumoconioses including beryliosis and silicosis as well as other allergic lung conditions. Reports of these lung conditions fluctuated across years. Some disparate conditions were grouped for analytic purposes, for example cases of carbon monoxide poisoning were included as acute respiratory conditions.

Table H-3.9: Lung Diseases by Type, ODSS, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
Respiratory	731	106	76	54	110	60	198	127
Asthma	243	38	49	35	20	27	33	41
Asbestosis/Asbestos Exposure	113	13	18	7	22	13	27	13
Other Lung	176	8	24	24	42	33	32	13
Total	**1263**	**165**	**167**	**120**	**194**	**133**	**290**	**194**

A wide variety of exposures caused lung conditions.

Respiratory conditions were mostly caused by chemicals, fumes, gas, cleaning agents, carbon monoxide, paint, metal fumes, dust, smoke, indoor air quality, mold, medical drugs and construction. Specific chemicals included fire extinguisher, acids, acrylamide, ammonia, cavelon spray, chromium trioxide, coal tar/pitch, ether, formaldehyde, formalin, floor stripper, gasoline fumes, hydrochloric acid, hydrogen chloride, hydroxide, methylene chloride, paint and paint thinner, polybutylene terephthalate, solvents, sulphuric acid, tar fumes from paving, toner powder for copy machines, varnish, xylene, and waste/sludge.

Asthma and RADS were caused by chemicals, mold, fiberglass, construction, animals, cleaners, fumes, smoke, exercise, and medicine. Specific chemicals were acrylamide, caustic soda powder, ethylene glycol, fiberglass, glues, bacteria, ink, isocyanate, bleach, pepper spray and soldering fumes.

Bronchitis, hypersensitivity pneumonitis, sinusitis, rhinitis, and Sick Building Syndrome were caused by chemicals including pepper spray, chlorine, fire extinguisher, metal working fluids, dust, indoor air quality, mold, fumes and fiberglass.

Lung cases mainly occurred in the manufacturing sector (exposure to chemicals, oils and fumes including metals), the service sector, towns and cities, and state government.

Infectious and Other Diseases

Since 1998, bloodborne disease exposures such as needle sticks have not been tabulated in the ODSS. Infectious diseases included bloodborne, tuberculosis (includes tuberculosis and PPD positive or conversion cases), human bite/urine reports and Lyme disease (Table H-3.10). The "other" infectious category included chicken pox, scabies and other unspecified infectious condition. Reports of infectious conditions were inconsistent across the years for bloodborne, human bite/urine, and Lyme disease.

Tuberculosis, PPD conversion and tuberculosis exposure reports fluctuated from 1995 to 1997, but the number of reports rose from 1998 to 2001(Table H-3.10).

Table H-3.10: Infectious Disease by Type, ODSS, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
Bloodborne	287	71	131	82			2	1
Tuberculosis	118	10	25	13	7	13	14	36
Human bite/Urine	10	4	4	2				
Lyme disease	31	2	13	4		4	6	2
Other infectious	61	6	5	17	2	6	5	20
Total	**507**	**93**	**178**	**118**	**9**	**20**	**27**	**59**

There were 275 reports of the "other" diseases. Long term and acute hearing loss combined for 97 reports. There were 36 cases of other allergic conditions, 33 cases of heat/cold conditions, 22 cases of mental stress, 18 cases of cancer reports, and 15 cases of heart/hypertension related conditions. Other cases in this group included, ring worm, and hepatitis conditions. These conditions were mainly from the service sector, towns and

cities, and the State of Connecticut, although manufacturing and other industry sectors also had cases.

H-4: Capture Recapture Analysis

As noted earlier there were a total of 30,786 cases for both databases ODSS and WCC, not adjusting for matched cases (Table H-1.2). There were 717 cases reported to ODSS and WCC, 9345 cases reported only to ODSS, and 20,007 cases reported only to WCC (Table H-4.2). This gives an adjusted total of 30,069 unique cases of occupational diseases that were reported to at least one system.

Table H-4.2: Capture Recapture Analysis, ODSS and WCC, 1995-2001

Case Type	Total	1995	1996	1997	1998	1999	2000	2001
Matches ODSS&WCC	717	49	85	94	94	132	147	116
ODSS only	9345	1102	1442	1348	1225	1170	1745	1313
WCC only	20007	1776	2039	1800	3348	4057	3947	3040
Total cases, adjusted for matches	**30069**	**2927**	**3566**	**3242**	**4667**	**5359**	**5839**	**4469**
Estimated uncaptured	**260761**	**39942**	**34591**	**25813**	**43631**	**35960**	**46854**	**34410**
Lower CI	**240295**	**28006**	**26639**	**20117**	**34081**	**29209**	**38610**	**27569**
Upper CI	**280500**	**50280**	**41738**	**30965**	**52262**	**42170**	**54465**	**40662**
Estimated total	**290467**	**42070**	**37755**	**28783**	**47839**	**41048**	**52376**	**38585**
Total Lower CI	**270364**	**30933**	**30205**	**23359**	**38748**	**34568**	**44449**	**32038**
Total upper CI	**310569**	**53207**	**45304**	**34207**	**56929**	**47529**	**60304**	**45131**

The total number of un-reported cases was calculated by multiplying cases reported only to ODSS by those reported only to WCC and dividing the total by the matched cases common to both systems. There were therefore a total of approximately 290,000 cases (95% confidence interval 270,364-310,569) of occupational disease in

Connecticut over the seven years (adding together the unique reported cases and the estimated unreported). The trend in total cases across the years shows an initial decrease from 1995 to 1997, followed by peaks in 1998 and 2000 and relative troughs in 1999 and 2001 (Table H-4.2). It is worth noting here that only MSDs, skin and lung/poison conditions were included in the capture recapture analysis. The "other" diseases and infectious diseases were not included because of inconsistency in reporting across years (figure H-4.6).

Musculoskeletal illnesses had the greatest number of matches (reports common to ODSS and WCC), 430 cases, compared to skin diseases, 148 cases, and lung/poison diseases, 98 cases (Tables H-4.3, H-4.4 and H-4.5). There was an increased trend of matched cases for MSDs, skin and lung/poison reports across the years until 1999. However, MSD and lung/poison matches decreased in 2001 while matches for skin conditions decreased in 2000 and increased in 2001.

The trend for un-captured MSD reports was such that cases rose from 1995 to 1996, then there was a drop in un-reported cases in 1997, an increase in un-reported cases in 1999 and finally a stable pattern for 2000 and 2001 (Table H-4.3 and Table H-4.6). It is worth noting that the number of un-captured cases in 2000 for MSD was relatively low possibly because of the higher number of reported MSD cases we had for that year.

Table H-4.3: Capture Recapture Analysis MSD, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
MSD Matches	430	36	41	60	61	61	108	63
ODSS MSD only	5783	620	941	883	741	761	1060	777
WC MSD only	9774	870	1058	866	1554	1927	1943	1556
Uncaptured MSD	**131449**	**14983**	**24282**	**12745**	**18877**	**24040**	**19070**	**19191**
Total MSD	**147436**	**16509**	**26322**	**14554**	**21233**	**26789**	**22181**	**21587**

Uncaptured skin conditions fluctuated between increases and decreases across the years but with the highest number of un-captured cases noted for the year 2000 (Table H-4.4). This trend is similar to lung/poison conditions where there was a decrease in reports from 1995 to 1997, followed by a fluctuating trend in the rest of the years (Tables H-4.5 and H-4.6).

Lung/poison reports had virtually no matches in 1995 and as such the number of un-reported cases was extremely high in that year (Table H-4.5); however, that number is very unstable and should be viewed with caution.

Table H-4.7 shows capture-recapture analysis by sector of industry. The wholesale/trade/retail industry had the highest proportion of matches relative to workers' compensation reports (6 %), followed by the manufacturing industry (5%), and the agriculture/mining/construction industry (4%). All the other industries had each had 3% of the matches except for the State of Connecticut with only 1% of the total matches.

Table H-4.4: Capture Recapture Analysis Skin, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
Skin Matches	148	6	13	19	19	34	22	35
ODSS Skin Only	1499	115	138	181	247	255	314	249
WC Skin Only	1502	122	141	180	251	309	266	233
Un-captured Skin	**15213**	**2338**	**1497**	**1715**	**3263**	**2318**	**3797**	**1658**
Total Skin	**18362**	**2581**	**1789**	**2095**	**3780**	**2916**	**4399**	**2175**

Table H-4.5: Capture Recapture Analysis Lung/Poison, 1995-2001

Illness	Total	1995	1996	1997	1998	1999	2000	2001
Lung/Poison Matches	98	3	8	10	15	15	29	18
ODSS Only	1322	259	189	139	183	120	261	171
WC Only	3012	300	301	313	581	479	592	446
Uncaptured Lung/Poison	**40631**	**25900**	**7111**	**4351**	**7088**	**3832**	**5328**	**4237**
Total Lung/Poison	**45063**	**26462**	**7609**	**4813**	**7867**	**4446**	**6210**	**4872**

Figure H-4.6: Matched Cases MSD, Skin, Lung/Poison

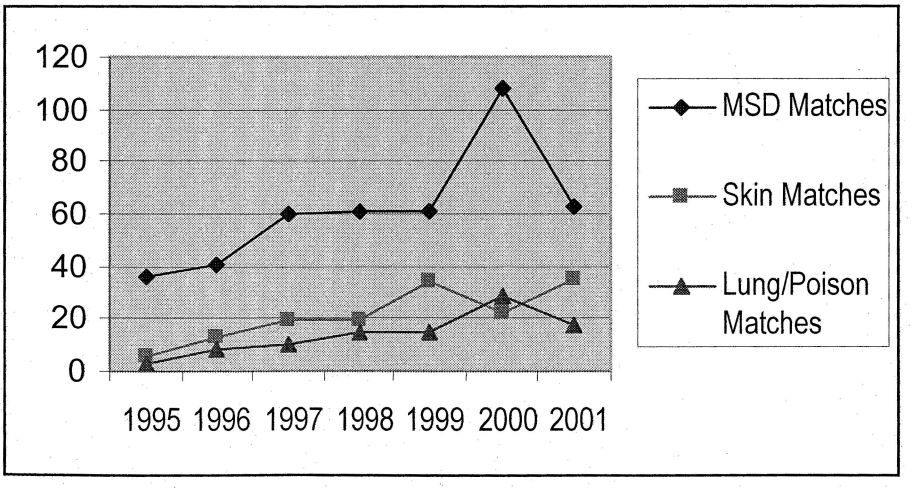


Table H-4.6: Total un-captured Cases MSD, Skin, Lung/Poison, 1995-2001

Cases	Total	1995	1996	1997	1998	1999	2000	2001
Uncaptured MSD	131449	14983	24282	12745	18877	24040	19070	19191
Uncaptured Skin	15213	2338	1497	1715	3263	2318	3797	1658
Uncaptured Lung/Poison	40631	25900	7111	4351	7088	3832	5328	4237

Table H-4.7: Capture Recapture Analysis by Industry Sector, 1995-2001

Agriculture/Mining/ Construction								
Industry Sector	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**Total**
Matches	2	6	5	6	7	5	3	34
ODSS Only	112	58	58	74	72	102	60	536
WCC Only	81	95	64	119	185	155	107	806
Uncaptured	**4536**	**918**	**742**	**1468**	**1903**	**3162**	**2140**	**12706**
Total	**4731**	**1077**	**869**	**1667**	**2167**	**3424**	**2310**	**14082**
Manufacturing								
Matches	21	21	32	25	35	57	43	234
ODSS Only	438	385	430	432	396	486	328	2895
WCC Only	426	488	404	588	725	809	687	4127
Uncaptured	**8885**	**8947**	**5429**	**10161**	**8203**	**6898**	**5240**	**51058**
Total	**9770**	**9841**	**6295**	**11206**	**9359**	**8250**	**6298**	**58314**
Transportation/ Utilities								
Matches	1	5	1	2	6	5	4	24
ODSS Only	37	59	70	40	43	108	70	427
WCC Only	85	102	75	134	176	105	119	796
Uncaptured	**3145**	**1204**	**5250**	**2680**	**1261**	**2268**	**2083**	**14162**
Total	**3268**	**1370**	**5396**	**2856**	**1486**	**2486**	**2276**	**15409**
Wholesale Trade/Retail								
Matches	15	14	15	21	23	14	7	109
ODSS Only	166	185	187	162	146	215	162	1223
WCC Only	189	254	178	272	350	324	237	1804
Uncaptured	**2092**	**3356**	**2219**	**2098**	**2222**	**4976**	**5485**	**20241**
Total	**2462**	**3809**	**2599**	**2553**	**2741**	**5529**	**5891**	**23377**

Finance/Insurance/ Real Estate								
Matches	2	6	6	4	3	7	4	32
ODSS Only	13	114	97	40	60	61	39	424
WCC Only	120	170	116	169	221	227	158	1181
Uncaptured	**780**	**3230**	**1875**	**1690**	**4420**	**1978**	**1541**	**15648**
Total	**915**	**3520**	**2094**	**1903**	**4704**	**2273**	**1742**	**17285**

Services								
Matches	5	25	32	30	28	28	17	165
ODSS Only	210	366	276	237	264	406	321	2080
WCC Only	246	557	486	737	1033	819	487	4365
Uncaptured	**10332**	**8154**	**4192**	**5822**	**9740**	**11876**	**9196**	**55025**
Total	**10793**	**9102**	**4986**	**6826**	**11065**	**13129**	**10021**	**61635**

Municipal								
Matches	1	7	6	7	16	19	16	72
ODSS Only	85	119	91	143	100	219	179	936
WCC Only	276	306	183	286	510	523	401	2485
Uncaptured	**23460**	**5202**	**2776**	**5843**	**3188**	**6028**	**4486**	**32305**
Total	**23822**	**5634**	**3056**	**6279**	**3814**	**6789**	**5082**	**35798**

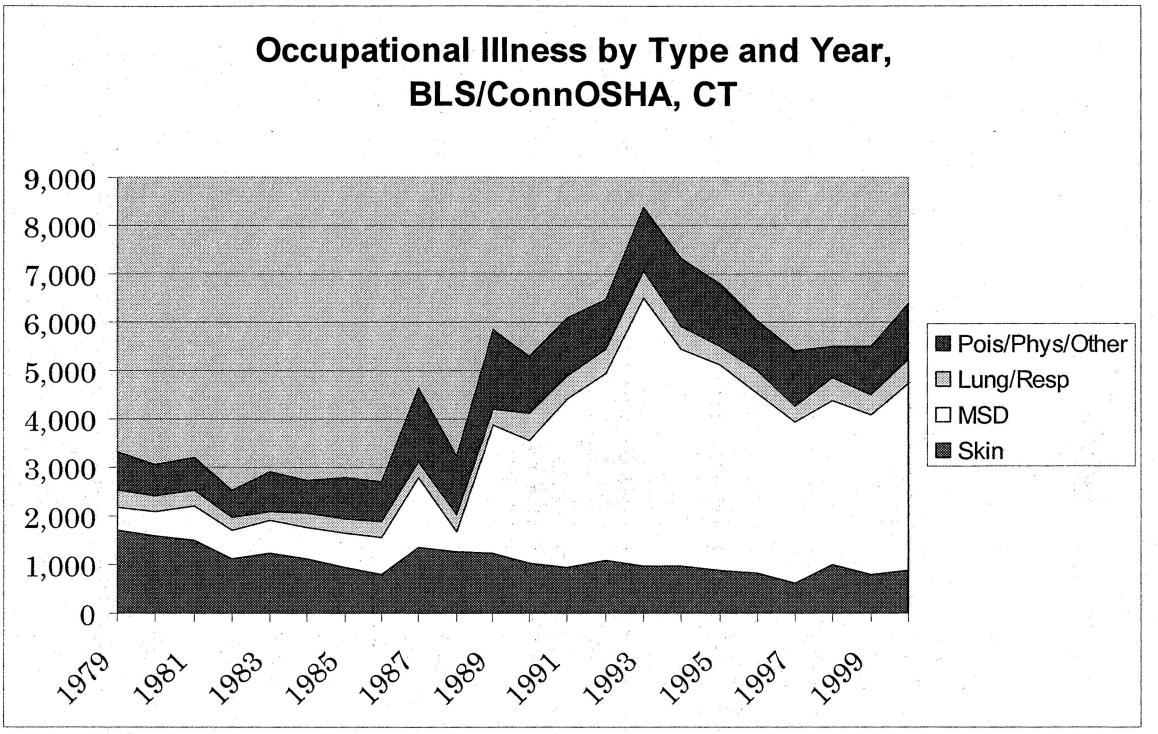
State of Connecticut								
Matches	1	2	1	4	10	13	27	58
ODSS Only	25	116	112	71	62	110	88	584
WCC Only	299	57	222	1006	838	926	749	4097
Uncaptured	**7475**	**3306**	**24864**	**17857**	**5196**	**7835**	**2441**	**41253**
Total	**7800**	**3481**	**25199**	**18938**	**6106**	**8884**	**3305**	**45992**

H-5: Bureau of Labor Statistics/Connecticut Occupational Safety and Health Administration Surveys (BLS/ConnOSHA)

In cooperation with the United States Bureau of Labor Statistics, Connecticut OSHA conducts an annual survey of employers for job-related injuries and illnesses. ConnOSHA issues an annual report that focuses the injuries. The Connecticut Department of Labor acknowledges that the survey under-counts occupational diseases, particularly chronic diseases.

Figure H-5.1 shows a general increase in trend of occupational illnesses from 1990 to 2001. Skin conditions on the contrary had a decrease in trend except for some slight increases in 1988, 1998, 1999 and 2001 not compared to initial levels in 1979.

Figure H-5.1: Occupational Illness by Type and Year, BLS/ConnOSHA, CT



In calculating the rates per 10,000 a similar pattern of increasing trend of occupational illnesses was noticed for all conditions starting from 1990 except for skin conditions which had a decreasing trend and gung conditions which stayed at a relatively constant high rate (figure H-5.2).

Figure H-5.2 shows MSD rates of the State of Connecticut higher than US rates across the years from 1992 till present. Though overall there is a decreasing trend of MSD rates Connecticut rates still almost double US rates for MSDs.

Figure H-5.2: Rate of Occupational Illnesses (BLS)

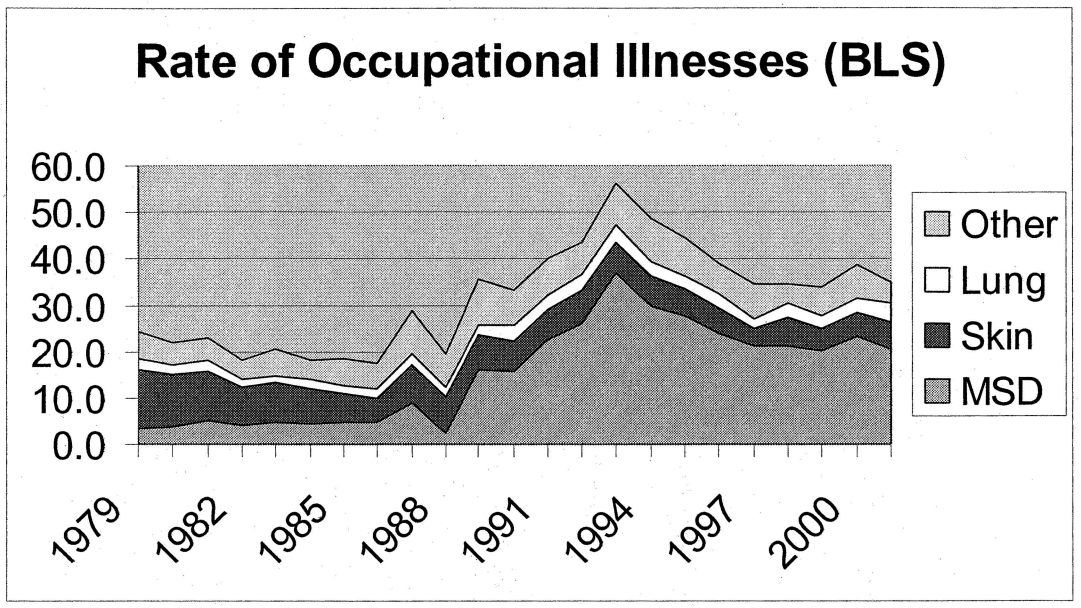
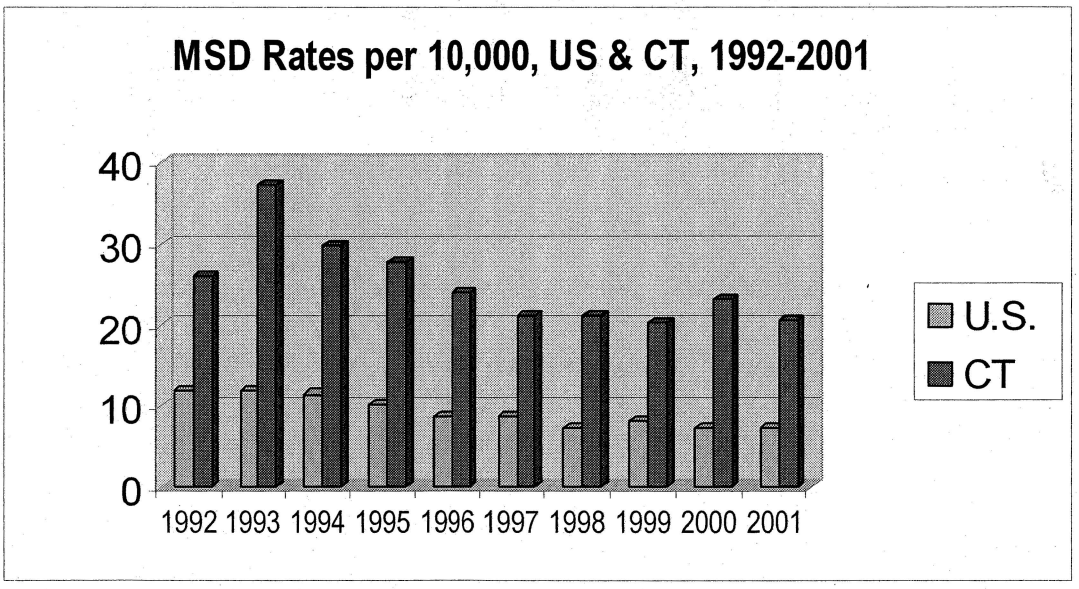


Figure H-5.3: MSD Rates per 10,000. US&CT. 1992-2001



I. Discussion

Passive surveillance is an approach to identify work related illnesses by using previously collected medical data such as insurance claims, safety records (such as the OSHA 200 log), BLS data, WCC and Physicians reports of occupational diseases. This approach may underestimate the true number of occupational diseases; for example, industries without in-plant medical services results in workers seeking treatment from his or her personal physician. Unless they request coverage under the workers' compensation system, the complaint and associated treatment may not appear in any company records.

Biddle et al noted employees of small companies or those who see their own physicians for work related diseases are largely excluded from the Michigan reporting system, since 90% of the reports are submitted by physicians working for the major manufacturing firms.[21]

The current seven year review of occupational illnesses in Connecticut using the WCC and ODSS surveillance data shows that occupational illnesses were under-reported for all the years. The estimate of under-reporting using the capture-recapture method for musculoskeletal, skin and lung/poison conditions showed a cumulative number of unreported cases across the years; 131,449 MSD cases, 40,631 lung/poison cases and 15,213 skin cases. Even though under-reporting by definition should vary as a factor of the ODSS reports, WCC reports and the number of matched cases between the two reports, there was no clear pattern to explain the increase or decrease in unreported cases across the years. The findings of under-reporting of occupational illnesses across the years using capture-recapture methods is supported by a similar study by Morse et al, in Connecticut in 1999.[7] In an attempt to estimate the true prevalence of MSDs in

Connecticut using capture-recapture methods and linking cases reported through ODSS and those through WCC there was very little overlap between the two systems even when this estimate was also compared to a second estimate using physician called cases from a UConn population-based survey in 1998. This was true with the seven years review showing very few matched cases (717) between the ODSS and the WCC databases. Utilizing ODSS data for 1995 and WCC data for the same year, there was an estimate of 13,285 cases of MSD (range: 8,800-17,052) in Connecticut. The results also showed that the ODSS captured only slightly more than 5% of MSD cases, based upon the number of cases reported by physicians to the ODSS in 1995 and 1998 when compared to the capture-recapture analysis average estimate of 13,500 cases in Connecticut.

The fact that physicians are not reporting seem to be a driving factor for under-reporting of occupational illnesses. Azaroff et al, in their study using the filter model of Webb et al in 2002, demonstrated some of the filters that results in reduced number of overall physicians' reports.[12] They attributed the lack of reporting of physicians to many factors such as; physicians' lack of awareness of the reporting law, physicians' lack of awareness that aggravation of existing conditions (such as asthma) from work exposures were reportable conditions, physicians' perception of that reporting to the government involved difficulties, physician lack of familiarity and difficulty with diagnosing occupational diseases, and physicians' workloads and demands on time for completing multiple record requirements.

Connecticut is one of the 33 states that require physicians to report known and suspected occupational disease to the Departments of Labor and Public Health but in 2000 only 95 physicians, mostly from occupational health clinics and programs reported

out of the total number of 13,374 licensed physicians in Connecticut.[14, 15, 31] This is true with other state reports such as in Massachusetts where only 25% of the 4836 cases of work related carpal tunnel syndrome reports documented by the Department of Health were from physicians. [10]

Rosenman et al. also found in their study of work related asthma in Michigan between 1988 and 1994 that only 0.7% of the approximately 30,000 Michigan physicians required by law to report occupational diseases actually complied.[8]

Azaroff et al points out that filters to recording incidents include neglect for the records, no training for the record keeper, no emphasis on maintaining records properly, downgrading recordkeeping to collateral duty of a clerical or support staff persons, poor communications between different departments within the company, (with the record-keeper kept uninformed of injuries and illnesses, when employees have reported them to their supervisors) and management bonuses and opportunities for promotion tied negatively to injury and illness rates.[12]

In the seven year review for example only 7353 reports included the age of the affected worker (Table H-3.1). Similarly, the WCC database had only 7,681 reports with age of workers listed correctly. There were also incomplete information on gender of workers, body parts affected, cause of injury, injury classification and description of injury in support for the above reasons of under-reporting.

In a Connecticut study Constanzo (1999) found that perceived barriers to reporting occupational diseases included uncertain diagnosis (78.9%), lack of time (60.5%), inconvenience (52.6%), too much paperwork involved (50.0%), fear ill employees may suffer negative consequences at work (26.3%), and forgetting to report

(23%).[32] Other barriers experienced with physicians by the DPH are lack of knowledge about reporting requirements, lack of knowledge about occupational illnesses and the small monetary penalty for not reporting[18, 19, 20, 32, 33]

Our current review for the past seven years shows a cyclical pattern. Both databases had an increase in reports between 1995 and 1996 followed by a decrease between 1996 and 1997. There was a steady decline in occupational illnesses based on ODSS reports from 1996 to 1999 (Figure H-1.1). This was followed by an increase in the number of reports in 2000 and a decline in reports there after. This trend was different for the WCC database which had a sharp increase in the number of cases from 1997 to1999, followed by a decline in 2000 and 2001. The increase in the WCC/ODSS occupational disease reports in 1995 and 1996 is an expected pattern during economic expansion as was the case in the mid to late nineties. [34] It is however difficult to explain the decreases in the number of ODSS/WCC cases in the light of the expected pattern of increased injuries and illnesses during economic expansions. Only a few physicians have been reporting to the ODSS system as reflected in the decrease of reports from 1996 to 1999. Both databases noticed a decrease in reports starting in 2000 that could be explained by underreporting and the beginning of economic recession.

Hugh et al in their study of occupational injury and illness rates, 1992-1996 attributed the decline in occupational injury and illness rates to legislative reforms motivated by increases in workers' compensation payments and growing awareness of workplace hazards by unions, employers, and the insurance industry.[34]

The same study suggested a possible explanation of the decline in occupational illness and injury rates was a decrease in employment in the traditionally high–hazard industries, accompanied by growth in low-hazard industries.[34, 35]

The seven year review for example had a decrease in employment figures for the manufacturing industry across the years (except for 1998, 276,700) from 279,300 in 1995 to 253,620 in 2001 which could explain the decline in reports of occupational illnesses. Contrary to this, employment in relatively low hazard industries in Connecticut for example the service industry continued to show strong long term growth, increasing from 452,300 in 1995 to 531,600 in 2000.[23, 24, 25.]

The magnitude of occupational disease in Connecticut is obviously very high and there is significant underreporting after studying trends of reports for seven years. The rates per 10,000 workers for occupational illness are relatively high for the manufacturing sector and relatively low for the service industry (See rates, Table H-3.4).

This trend study is an example of the use of an epidemiologic surveillance system which consists of the ongoing and systematic collection, analysis, and interpretation of data related to health. The findings of underreporting, and changes in rate trends will be to plan, implement and evaluate public health interventions related to the work place and in policy making. In Connecticut the occupational health program has a goal of preventing occupational diseases. This data from the ODSS/WCC on occupational disease in the Connecticut workforce will continue to be used to guide follow-up and intervention activities at multiple levels: that of the individual worker, the workplace, and the industry sector so that further disease can be prevented. The trend data on occupational disease occurrence, rates per industry sector and information on

underreporting will be shared with physicians and other health care providers, with local health departments, with agencies, industry sectors and with professional organizations which have expertise in occupational safety and health. These institutions will therefore use this as a tool in planning, monitoring and evaluating the overall effectiveness in new and ongoing worksite programs as well as in targeting the appropriate allocation of resources.

J. Appendix

Comparison of Databases, WCC, ODSS, and BLS Survey-OSHA 200Logs

	BLS Survey-OSHA 200 Logs	Workers Compensation	ODSS Physician Reports
Who Reports	Employers	Employers	Physicians, Labs
Source of Reports	OSHA 200 Logs	First Report of Injury Forms	Reports to DOL: DPH Commissioner
Physician Diagnosed only	No	No	Yes
Federal Workers included	No	No	Yes
Self-employed included	No	No	Yes
Non-lost time cases	Yes	Mainly No	Yes
Personal Identifier data	No	Yes	Yes
Total cases included	No (Sample only)	Yes	Yes
Time delay of reports	Up to two years	1-3 years	48 hours-2 months
Trend data	Yes	Yes	Yes
Comparable national data	Yes	Yes	No
Injury data	Yes	Yes	No
Includes chronic diseases with long lag time for symptoms	No	Poor	Better
Calculation of rates	Yes	Yes	Yes
Physician participation with reporting	Not required	Needed for disputed claims	Required by statute
Extent of physician reporting	Not applicable	All	Mainly physicians in DOL funded Occupational Medicine Clinics
Data used for follow-up, intervention, education	Used for industry-wide targeting and enforcement	Used for education only	Used for follow-up, education, intervention

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